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Heating Piping & Air Conditioning

DESIGN
INSTALLATION
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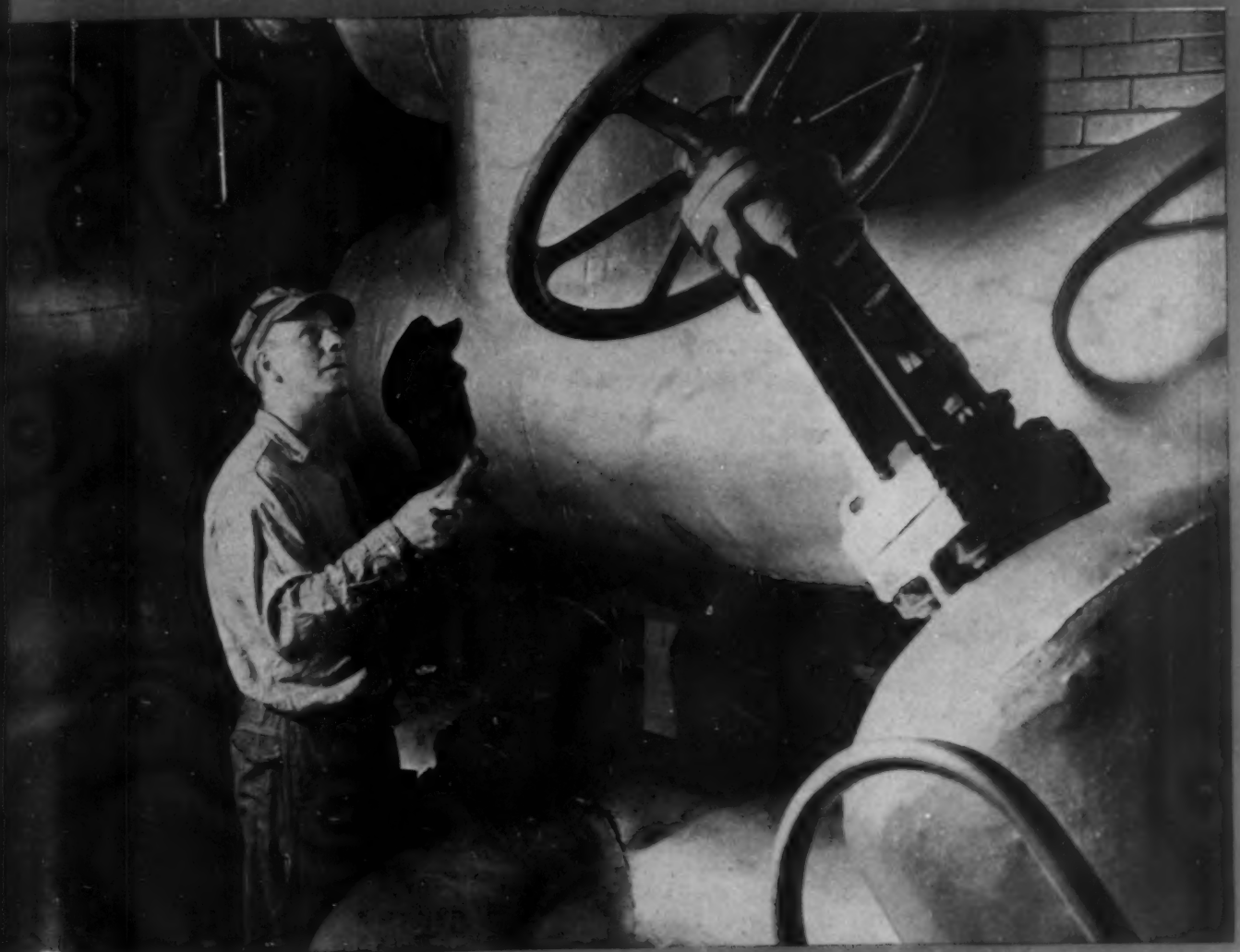
MARCH ★ 1946

INDUSTRIAL
COMMERCIAL
INSTITUTIONAL AND
PUBLIC BUILDINGS

101 — Journal Section of the American Society of Heating and Ventilating Engineers



A water tender inspects a big valve in the Washington, D. C., central heating plant serving over a hundred government buildings

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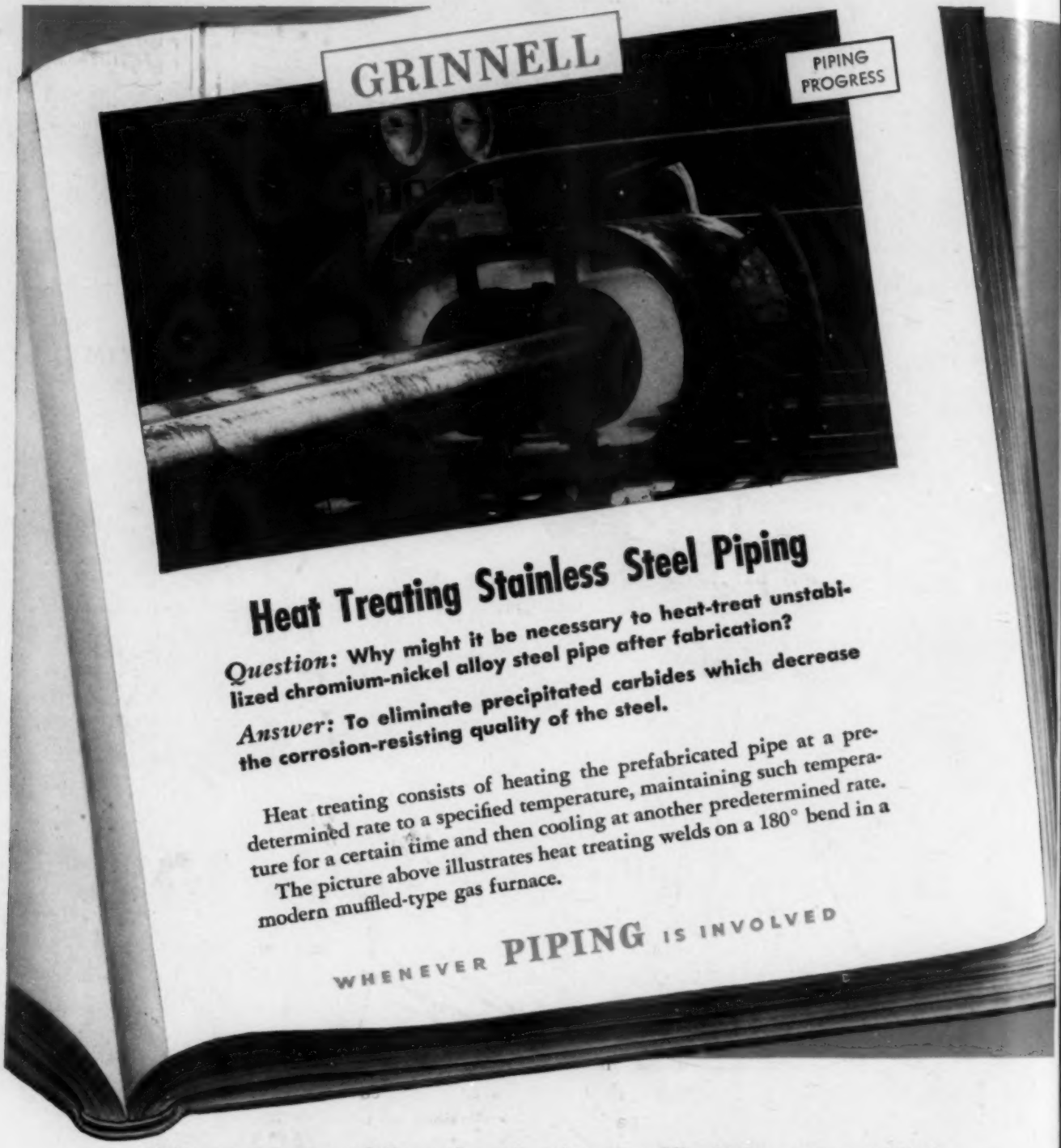

Heat Treating Stainless Steel Piping

***Question*: Why might it be necessary to heat-treat unstabilized chromium-nickel alloy steel pipe after fabrication?**

***Answer*: To eliminate precipitated carbides which decrease the corrosion-resisting quality of the steel.**

Heat treating consists of heating the prefabricated pipe at a predetermined rate to a specified temperature, maintaining such temperature for a certain time and then cooling at another predetermined rate. The picture above illustrates heat treating welds on a 180° bend in a modern muffled-type gas furnace.

WHENEVER **PIPING** IS INVOLVED

There are many types of alloy steel – each with its own particular properties and characteristics, such as reactions under the heat of welding and bending. Grinnell engineers are familiar with these reactions and have developed closely controlled and metallurgically supervised procedures for fabricating alloy piping to obtain the full advantages of alloy steels for corrosion resistance and for high pressure and high temperature applications.

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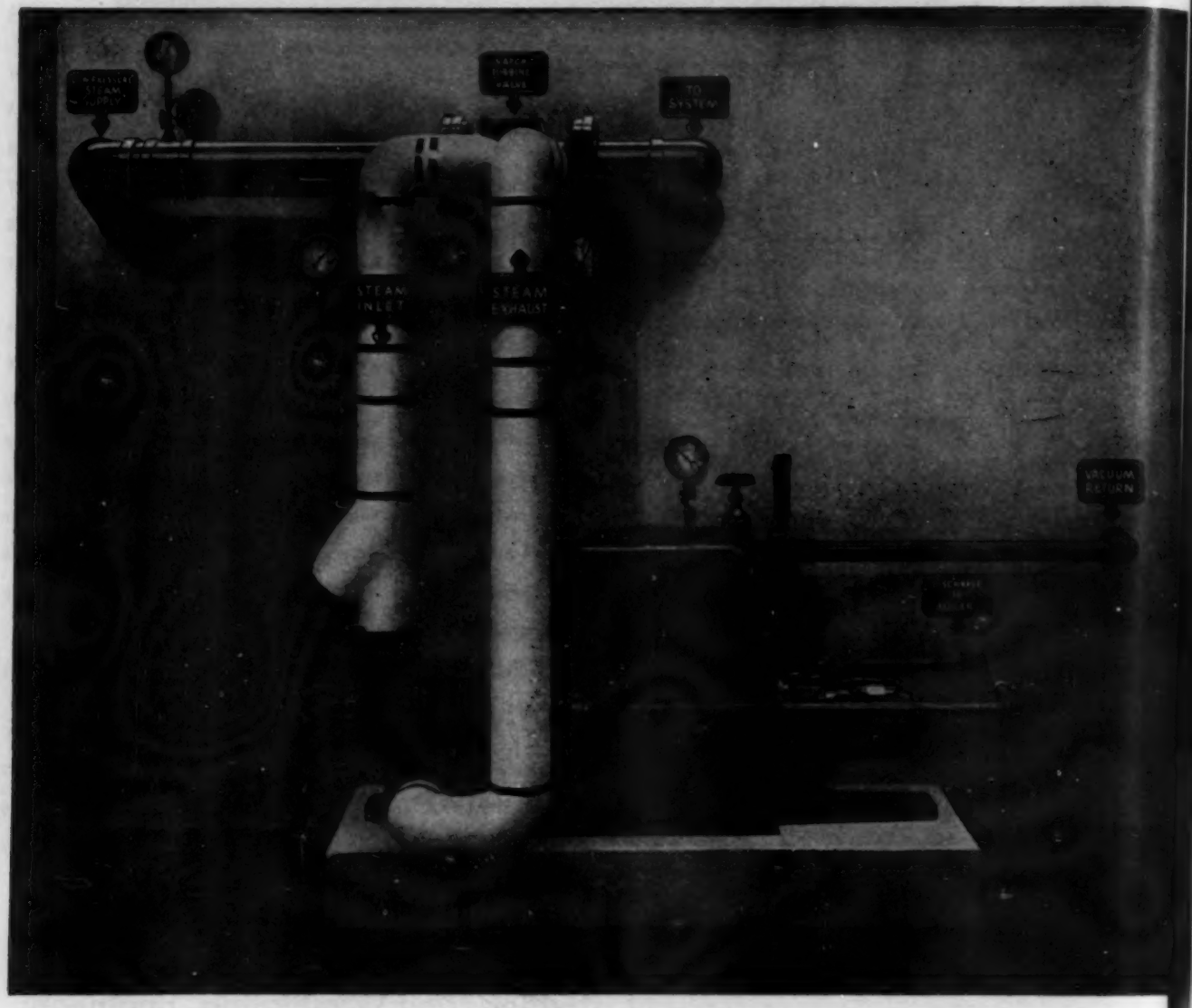
Interrupted Electric Service will not stop this NASH Heating Pump!



In Hospitals, Greenhouses, Schools, Public Buildings, Theatres, wherever heating systems must not fail, install the Nash Vapor Turbine, for it is independent of electric current failure, and continues to operate as long as there is steam in the system.

This is because the prime motive power of this economical pump is a special steam turbine, controlled by a unique "Vapor Turbine Valve", which automatically bypasses from the heating main a small portion of steam, the exact amount necessary to develop the power needed to re move the condensate and maintain th required vacuum on the system. Even thi small amount is passed immediately bac to the mains, and goes on to the syste with little heat loss. This pump operate on any system, high or low pressure.

The Vapor Turbine is a most economica pump, for the elimination of electric curren does away with current cost, the larges single item in the operation of an ordinar return line heating pump. Bulletin on reques

THE NASH ENGINEERING COMPANY

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DEHUMIDIFICATION PROTECTS U.S. NAVY'S INACTIVE FLEET

Acme

CAPTAIN T. H. URDAHL and Commander E. R. QUEER give details of ship preservation program.

WITH THE end of World War II, preservation measures to implement the U. S. Navy's "Keep the Fleet" program are not only well defined, but are already being applied.

At the end of World War I, the same factors which make up the problems of preservation were as well known as they are today—but the "engineering link" between desirability and practicability had not been forged. The preservation methods employed then comprised the application of materials readily at hand. These consisted principally of red lead and grease, which provided a quality for preservation far inferior to similar materials available today. Such ineffective and costly methods have served as an ample reminder of the necessity for a more adequate means of protecting our naval vessels against the ravages of atmospheric corrosion.

Today, approximately 2700 ships of combatant and noncombatant types are being protected by employing scientific means of dehumidification, painting, thin film rust preventive compound application, and tight packaging. The speed at which the ship so preserved can be returned to an active status has been a primary consideration in the selection of preservation methods. Through these procedures, both quick and inexpensive, it is certain that our Navy will remain in an excellent condition of readiness for many years.

The problem presented in the preservation of a ship involves the following factors:

1) Moisture and atmospheric conditions cause corrosion of metals, mold, mildew, and general deterioration of equipment and materials aboard.

2) The removal of equipment and materials for storage ashore is expensive, and storage offers no protection against deterioration unless adequate treatment is applied.

3) Adequately closing a ship's hull provides an excellent vapor and water barrier and quantities of atmospheric moisture admitted by breathing and infiltration can thus be controlled.

4) Preservation by means of coatings alone is not sufficient.

Ship Is Storehouse for Its Equipment

The solution most immediately apparent in analyzing these factors is that of using the ship as a storehouse for all of its own required equipment. The ship must be made as tight as economically practicable against the admission of outside

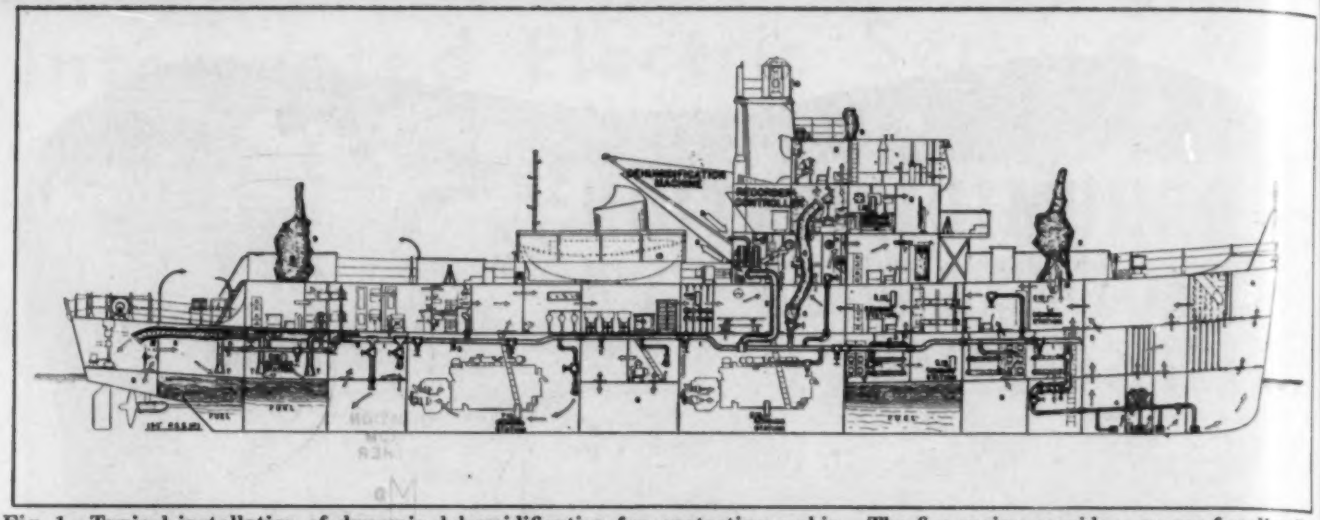


Fig. 1—Typical installation of dynamic dehumidification for protecting a ship. The fire mains provide a means for distributing the small quantities of dry air, fire protection being provided from the shore and from fire boats. A controller-recorder of unique design is connected to eight stations for sensing the relative humidity in spaces throughout the ship

air and moisture. The atmosphere within should then be maintained at a relative humidity of 30 per cent or less, since at this point, it has been determined that general deterioration is inhibited for an indefinite period.

The practicability of obtaining this solution to the problem was dependent upon the development and manufacture of equipment which could maintain the desired low humidity condition under the entire range of weather conditions prevailing throughout the year in any of the 14 berthing areas variously dispersed about the continental United States. Also basic to the matter of obtaining adequate equipment was quantitative data concerning the moisture loads to be removed, in order to arrive at economical unit sizes to cover the space requirements of various types of vessels.

A great deal of thought has been given to this and similar preservation problems over the past 20 years. Some development work had been carried on toward providing equipment of a satisfactory type to accomplish the desired control of humidity just prior to World War II, at which time the Navy's development efforts were diverted to the essentially higher priority of active fleet equipment.

However, the past work had formed a basis for recent developments for future requirements. The dehumidification of vessels for cargo preservation had been successfully accomplished by one company, who pioneered the idea. All of this background—including that with cargo vessels—contributed to pointing out the many difficulties and variables that such a problem involves, and (by no means least) showed the necessity for the development of more practical and efficient dehumidifying equipment.

The present program—and the equipment which is basic to its success—was begun, evolved, and completed in the last two years, with the assistance and advice of many manufacturers and consultants whose various contributions were carefully screened, considered, and finally molded by the Bureau of Ships into a composite idea upon which the Navy was able to proceed. Test installations were made in various localities on various types of inactive vessels for the purpose of determining the practicability of these preservation measures. Dehumidifying machines were designed, tested, and redesigned to obtain the desired efficiency and ruggedness of construction for long life with minimum attention.

AIR CONDITIONING continues to play an important role in national defense in the Navy's huge ship preservation program, wherein vessels are assigned to the "inactive fleet" and protected against the ravages of corrosion and deterioration by means of dehumidified air. The economy of this method—it is estimated that the dehumidification power cost for protecting the $100 million investment in a battleship, for example, will be but $1550 annually—is attractive, as is the fact that America's seapower will be in readiness for emergencies. . . . Captain Urdahl, USNR, and Commander Queer, USNR, both of the Bureau of Ships, describe here the equipment for both dynamic and static dehumidification, the procedure for employing it, and the ingenious method of recording and control to assure that proper relative humidity conditions are maintained throughout the ships. It has been determined that the atmosphere should be held at 30 per cent or less relative humidity for protection.

The results have produced dehumidifying machines employing solid chemical desiccants and a method of control of these machines combining the features of averaging, recording, and indicating. In addition to these, there are other means of moisture removal with static desiccants, methods of packaging deck equipment and ordnance, and—under certain conditions—the application of preservatives on bright steel surfaces. With the equipment now being installed, the ship virtually becomes a dry storage warehouse and the necessity for additional storage ashore is eliminated.

Orders to "Inactive Fleet"

Upon receipt of orders to the "inactive fleet," the ship proceeds immediately with preservation measures. Upon reporting, all urgent repairs are accomplished and the ship is drydocked to apply new antifouling paint and to have other essential underwater work undertaken. There is an immediate one-

third reduction of the wartime complement by detaching the special, radar, communications, and gunnery ratings.

Preliminary preservation measures, consisting of cleaning and drying the ship's hull and machinery, are accomplished and thin film rust preventive compounds are applied. The equipment is ready for immediate use without the removal of preservatives. Although there are few vermin, germs, and insects on naval vessels, prior to final closure the ship is completely fumigated.

During these initial preparations, the dehumidification equipment is installed according to plan and made ready to operate. The last stage before the ship goes under dehumidification is to seal the envelope from the sea and the weather and to open doors and hatches within the ship, as needed for the dry air flow. However, the watertight integrity of the ship is maintained at all times. Although it is desirable to make the topside as tight as practicable, it is not essential that the ship be made pressure tight to secure good economy of operation; watertightness, however, is absolutely imperative but easy of attainment.

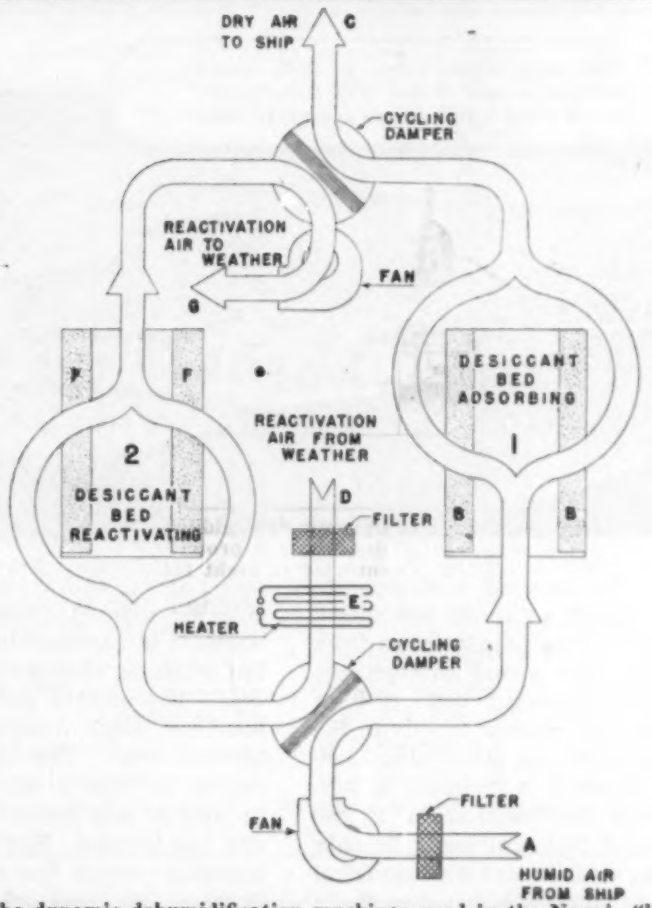


Fig. 2—The dynamic dehumidification machines used in the Navy's "keep the fleet" program are of the dual bed type, as shown in this diagram of the general arrangement. Humid air is drawn from the ship and passed through the adsorbing desiccant bed, and a second air circuit is provided for reactivating exhausted desiccant bed (silica gel or activated alumina).

Dynamic and Static Dehumidification

Dehumidification is accomplished both dynamically and statically.

Dynamic dehumidification consists of forcing the ship's air through an automatically controlled and reactivated chemical desiccant machine connected to a distribution system. The fire mains are drained and, since they extend throughout the ship, they provide an excellent means for distributing the small quantities of dry air and return flow is controlled by choice of closure of access openings. (Fig. 1 shows a typical system.) Fire protection is provided from the shore and fire boats. The distribution does not have to be positive to all spaces, for it has been determined by test that diffusion will provide satisfactory distribution for inner bottoms, appending tanks, and voids.

Static dehumidification is obtained by placing metal containers of desiccants in closed voids, tanks, and metal packages. This system is used only in spaces that cannot be easily reached dynamically or where the watertight integrity of the ship would be violated through opening doors, hatches, and manholes. Only about 5 per cent of the overall inactive fleet dehumidification will be accomplished statically.

The process of dehumidification is divided into two stages: initial drying and maintenance drying. During the initial drying period, all free water is removed from the bilges; steam, water, and drainage piping; and boilers and machinery. Portable dynamic machines are used to pre-dry. After the predrying is accomplished and the main dynamic system put into operation, the moisture load is composed of air-entrained vapor and a considerable quantity of water vapor adsorbed in the painted surfaces, lines, mattresses, etc.

In initial drying the machines will operate continuously for four to six weeks, drawing the adsorbed water from the surfaces while the space humidity is reduced to 30 per cent. During the maintenance drying stage the moisture load is reduced chiefly to breathing caused by diurnal changes of temperature, infiltration, and such topside and underwater leakage that may inadvertently occur. Such leaks must be found early and caulked, otherwise the dehumidification machine becomes "a costly bilge pump."

The Dehumidifying Equipment

For the most economical use of the equipment, the machine capacity should be installed to take care of that amount of ship's space to provide 12 hr per day of operation during the maintenance stage. Since breathing is the major load, the machines operate principally at night and the early morning hours. The relative humidity decreases during the day because of rising temperature, and rises at night because of falling temperature and breathing of weather air.

Dynamic dehumidifiers—The dynamic machines used for the Navy's inactive fleet are the dual bed type, and desiccants employed are silica gel and activated alu-

This aerial view, taken in 1928, shows decommissioned World War I destroyers at the Navy's San Diego destroyer base.

mina. The general arrangements of the machine circuits are shown in Fig. 2. Humid air is drawn from the ship and passed through the adsorbing desiccant bed. A high pressure fan returns the air to the ship through the distribution system. A second air circuit is provided for the reactivation of the exhausted desiccant bed. In this, weather air is heated with electrical elements situated either directly in the desiccant or by strip heaters in the air stream. The effluent reactivation air is discharged overboard to the weather. The control of the cycles (switching beds) is accomplished automatically with a timer or a thermostat.

Most of the requirements will be taken care of with three standard sizes of machines. A summary of the specifications for the dehumidifier units is given in Table 1.

Package dehumidifier.—The package dehumidifier is a single bed type developed for drying metal packages over mounts, guns, and searchlights, and it is also available for isolated compartments to which it is uneconomical to extend the dynamic system from a ship zone. The unit is also capable of handling small vessels, such as landing craft. The cycle on this unit is automatic, consisting of 2 hr and 25 min adsorption, and 35 min reactivation. The package dehumidifier—with the proper reactivation air connections to the weather—can be substituted for the portable dehumidifier mentioned hereafter.

Table 1—Summary of specifications for dehumidifier units

	Package	Small Size	Large Size
Adsorption air, cfm	20	150	500
Connected load, kw	1	3	8
Static pressure external to machine, inches water	⅛	3	5–½
Adsorption capacity, lb per hr			
95 F, 35% relative humidity	5.4*	2.6	7.5
70 F, 35% relative humidity	5.0*	2.0	5.5
40 F, 35% relative humidity	2.9*	..	2.5
Reactivation economy, kw hr per lb of water			
95 F, 35% relative humidity	0.80	0.90	0.95
70 F, 35% relative humidity	0.85	1.00	1.00
40 F, 35% relative humidity	1.40	...	1.25

*Lb per day.

Portable dehumidifiers—The portable dehumidifiers are used for initial drying of compartments, freshwater tanks, piping, boilers, etc. They have been found useful for initial drying of spaces that are to be treated statically and before and after painting. The unit consists of a container called a "desiccanister" filled with 40 lb of silica gel. To this is attached a fan with a heater unit. Air from the compartment to be dried is circulated through the desiccanister. In drying piping, the ship or weather air is predried and forced through the pipes. When the desiccant is exhausted three indicator gel ports show a pink color. The desiccanister is reactivated by removing the unit from the compartment to an undried portion of the ship or to the weather and using the builtin electrical element to heat the air passing through the desiccant, until the indicator ports again show blue. Each unit is supplied with two desiccanisters.

"Desicans"—The static dehumidification is accomplished by placing approximately 5½ lb of silica gel in a permanent aluminum container with perforated surfaces. Each container is provided with a port containing indicator silica gel. These units are called "desicans" and come packed eight or nine in a metal drum carrying case.

Breathers—Fuel tanks will contain oil or be coated with oil as a means of protection. Diurnal changes in temperature will cause breathing and, to prevent an accumulation of condensed atmospheric moisture in the tanks, breathers are provided on the weather vents. The breather for fuel tanks contains an inexpensive desiccant that can be discarded. Desiccants will adsorb oil vapors which—in addition to producing a hazard during reactivation—will carbonize and damage the desiccant. Breathers may also be used on metal packages under static dehumidification. Some thought is being given to the development of a solar reactivated breather.

Reactivator—An automatic temperature controlled electric oven is provided to reactivate the desicans and those breathers which may be used on metal packaging. The air is heated to 325 F and circulated with a fan.

How Humidity Is Controlled

The relative humidity in the dynamic zones is controlled and recorded by a controller-recorder of unique design. This instrument is a combined development of the Bureau of Ships Air Conditioning Section and an instrument manufacturer.

The instrument consists of a main control and recording station to which are connected eight stations for sensing the relative hu-

midity; in addition, each sensing station contains a temperature element. A record of the temperature and humidity is printed in arabic numbers on an adding machine strip paper once every 15 min continuously or once every 12 hr as desired. The identifying station number and the time are also printed.

For control purposes the instrument continuously averages the relative humidity at the eight sensing stations. If the average ship's relative humidity rises above, say, 33 per cent, the dehumidifier will be turned on and continue to operate until the average is worked down to, say, 27 per cent. The differential is adjustable so as to prevent short-cycling of the dehumidifier.

The controller-recorder assists in balancing the distribution of dry air in the ship. If the humidity at a particular station is running above 35 per cent relative humidity, the air control valve (a fire main valve) in that subdivision of the ship is opened to allow an additional amount of dry air into that subdivision. Conversely, if another subdivision is below 25 per cent relative humidity, then the control valve for that section can be adjusted accordingly. With the aid of a simple, direct reading, air flow meter developed by the Bureau of Ships these adjustments can be made by an enlisted man serving on watch. In the event of persistently high values of humidity, an inspection must be made to determine the source of moisture and corrective measures taken. This instrument will contribute much toward reducing the cost of maintaining the inactive fleet in future years.

In conclusion, it can be said that dehumidification, as carried out by the above procedure, is an economical means of preserving a costly investment in valuable ships. The installed equipment cost is less than 1c per cu ft of ship's volume in the majority of cases. The power cost will run well below 15c per 100,000 cu ft of volume per day with power at 1c per kwhr.

Dehumidification Protects a Costly Investment

The attendant dehumidification power cost for a destroyer having a volume of approximately 250,000 cu ft will be about $110 per year on a $7,000,000 investment. A 35,000 ton battleship, costing from 90 to 100 million dollars, would have an attendant dehumidification power cost of $1550. Therefore, it is obvious that the economy of dehumidification as a preservation measure is attractive to the taxpayer. In addition, preservation with dry air will provide an excellent means of preserving America's seapower in a state of readiness for any and all emergencies.

THE VETERANS COME HOME

By Col. Emmett G. Solomon

Chief, Veterans Personnel Division, Selective Service System

OUR SOLDIERS and sailors are coming home from war. Eventually, these ex-service men and women will comprise nearly 10 per cent of the nation's population. They are likely to be the country's leaders in business and political fields for the next generation.

Today they are returning to the community as its most valuable source of potential workers. The average veteran will be in better health than when he went away. He probably will have obtained a good deal of technical training and work experience. Most service men and women have traveled through other parts of the United States as well as foreign countries. Many will have gained new understanding and maturity from their military experiences around the globe.

By and large, they have carried responsibility beyond their years; they have faced death. And, in spite of all the horrors of war, the average veteran is likely to return greatly improved, physically and mentally, by his experience.

The majority of veterans do not return to civilian life disabled or in need of vocational rehabilitation. But this fact does not in any way lessen the responsibility and obligation of government, labor, and industry. We have both a legal and moral obligation to see that the veteran is assisted in taking his place in his old community with the least amount of confusion or unnecessary delay. However, we must guard against the prevalent thought that we are patriots discharging an obligation. There has been too much of that attitude. Rather, we must keep in mind the fact that government, labor, and industry have much to gain by the return of many thousands of valuable members of the nation's economy. If we make our plans from this practical approach to the problem, the veteran and employer will profit alike.

In most cases, the kind of work for which a veteran is best suited will depend largely on the experiences he has had as a civilian, together with those acquired while in service. It is easy to understand how former civilian experience can be useful, but some employers have not yet recognized how much military training has added to the veteran's value as a potential employee.

Few people realize that about one-third of all army jobs are related directly to civilian occupations, one-third indirectly related, and all related in some way. The long list of military occupations includes 1028 job titles, related to nearly 17,500 civilian jobs covering 130 industries.

PRESENTS MODEL SMOKE LAW

ASME Group Develops Example Sections for Regulation Ordinance

JUDGING FROM the amount of newspaper and magazine space which is currently being devoted to the subject, together with the lively discussions one hears on all sides, it is apparent that smoke abatement is becoming increasingly important in the minds of civic leaders, city government officials, and the residents of many communities. Certainly no one wants unclean air.

Recognizing that "no smoke law can satisfactorily meet the needs of all communities or provide an arrangement of words for legal purposes that would satisfy all lawmakers," the model smoke law committee of the fuels division of the American Society of Mechanical Engineers has prepared Example Sections for a Smoke Regulation Ordinance, which was presented at the society's 1945 annual meeting.

Designed to provide helpful information to those developing an ordinance to improve the cleanliness of air in their community, this paper is just what its name implies. Written in the general form of a model smoke ordinance, it is divided into 15 sections and contains numerous comments which explain the intent and reasons for the various sections. It is understood that the material is still in a preliminary form.

Smoke Regulation Department

After defining terms commonly used in connection with smoke abatement, the creation and organization of a department of smoke regulation is dealt with; such a department would comprise (1) an advisory board composed of five members, three of whom shall be technical engineers, (2) an appeal board of five members of similar constitution to the advisory board, and (3) a chief smoke regulation engineer. The members of the boards and the engineer are to be appointed by the mayor subject to the laws of the community. In addition, the chief smoke regulation engineer shall have qualifications at least equal to those required for full membership in the ASME, shall be a licensed professional engineer of the state or commonwealth, and shall be a civil service employee properly bonded at the expense of the city. The amount of the engineer's salary, in keeping with his qualifications and duties, is stressed in the explanatory notes and it is pointed out that many cities have attempted unsuccessfully to obtain the services of a capable man at an unattractive salary.

Broad Powers Given Engineers

Noteworthy among the provisions set forth are the powers given the engineer. He is authorized to "prepare and promulgate, with the advice and approval of the advisory board, rules and regulations for the installation and operation of fuel burning equipment and all other devices susceptible for use in such a manner as to violate the provisions of the ordinance; as to the kind of fuel to be used for various types of equipment; and as to necessary auxiliary devices that aid in meeting the requirements of the ordinance." In addition, the engineer—with the advice and approval of the advisory board—may from time to time alter, revise, rescind, and amend the various rules and regulations.

It is considered that the preparation of the rules and regulations is strictly an engineering function. Because of changes in such factors as available fuel supplies, advances in the art of fuel burning, and in the design of equipment, changes in the rules and regulations will, from time to time, be advisable and it is stated that experience has shown that placing the rules in the body of the ordinance is inadvisable.

Other sections provide for submitting plans for approval before a permit is granted for any installation or alteration of fuel burning equipment. Operating permits for persons engaged in the operation of fuel burning equipment, and yearly inspections of existing equipment, are also required. In regard to smoke densities, the periods and conditions under which a shade or density equal to or greater than No. 2 of the Ringelmann chart will be tolerated are fully set forth. In addition, dust in the flue gases is limited to 0.85 lb per 1000 lb of gases, adjusted to 12 per cent CO_2 content for products of combustion. To assist the engineer, all dealers and vendors of solid fuel are required to provide with each delivery a certificate or bill of sale on which is plainly indicated the name of the person or firm making the sale or delivery and the volatile content, on a moisture and ashfree basis, of the fuel correct within ± 2 per cent. All sales of fuel burning equipment must be reported to the department of smoke regulation within 10 days from date of sale.

Sealing Equipment

Violation of an installation or operating permit or violation of the yearly certificate of operation is considered sufficient grounds for the engineer to stop all work and seal the equipment. Any person taking exception to any decision, ruling, regulation, or order of the chief smoke regulation engineer may appeal to the appeal board, whose decision shall be binding on the engineer. For those instances where violation of the ordinance occurs, it is recommended that the engineer be given the power to cite any or all such persons for violations, the ultimate verdict as to each individual being determined through normal court procedure.

Inasmuch as these example sections are clearly written and are presented in a general form, they should be of considerable help to those engaged in developing a smoke ordinance. They may be modified to suit various forms of city government and various degrees of smoke densities which may be tolerated.

J. F. Barkley is chairman of the model smoke law committee.

Construction view showing floor, wall, and ceiling panel test installation at Purdue. How to choose the correct location and how to calculate the area of supplementary panels when they are required is explained in the text.

RADIANT HEATING ?
Floor, Wall, or Ceiling

F. W. Hutchinson Tells How to Choose Proper Location for Panel Heating; Table Gives Equivalent Panel Areas

HOW TO DECIDE between floor, ceiling, or wall location for radiant heating panels is explained by the author, who is professor of mechanical engineering at Purdue University and is widely known for his extensive work on this subject. He gives a table from which coefficients can be obtained to permit approximate transformation of a known area of one type of panel to an equivalent area of some other type. Based on conventional design assumptions, a wall panel installation will require less area than any other type—while a ceiling installation will more closely approximate (in performance) the desired attributes of a radiant panel system. The author says that for rooms of average size, floor-type installations possess neither thermal nor radiant advantages; but for unusually large rooms with high ceilings floor panels are preferable, while for average rooms with high ceilings wall panels are preferred

THE first decision required for an engineer designing a radiant panel heating system is where to locate the panels. Should they be in the ceiling, floor, interior walls, or exterior walls? In many cases the conditions of the particular problem are such that one or more of the alternatives are automatically ruled out, but in other instances load conditions are such that the engineer has complete freedom of choice and must select a position in terms of his own judgment of the relative merits of the four possible locations.

The location most likely to prove impossible is the floor; for an average installation, a floor panel must be more than twice as large as either a wall or ceiling panel of equal capacity and hence it is hardly surprising that many structures, particularly in cold climates, do not have sufficient floor space to permit installation of the requisite amount of surface. In such cases the alternatives are to use some panel location other than the floor, or to install a floor panel and supplement it with additional wall or ceiling heating surface. If the latter is the choice, the designer will require some simple means of converting the calculated area of excess floor panel to an equivalent area of supplementary wall or ceiling surface.

Existing Information Summarized

The intent here is to summarize existing information on the thermal and comfort characteristics of different panel locations and to provide a simple tabular method of converting areas calculated for one location to equivalent areas for use in some other location. At the same time, the relative merits of the various locations will be discussed with respect to their effectiveness —or lack of it—in providing those particular characteristics which are said to be associated with *radiant* heating.

The designer will still be lacking, however, some of the data required for a final decision, since the importance of the thermal or comfort characteristics of any location can

A technical paper prepared in cooperation with the housing division of the Purdue Research Foundation: G. Stanley Meikle, research director of the foundation; Carl F. Boester, housing executive.

only be evaluated in terms of the cost of achieving such an installation. No attempt is made here to estimate the comparative costs of floor, ceiling, and wall panels. Such a comparison necessarily depends on the type of structure and the specific conditions of the particular installation. Based on his own experience and that of his immediate associates, the local engineer or contractor is in a far better position to estimate comparative costs than is anyone else.

The most outstanding difference in the operating characteristics of floor, wall, and ceiling panels arises from the marked increase in the convective film coefficient of heat transfer which occurs as the heating surface is rotated through 180 deg from the ceiling position. A ceiling panel, particularly if it is large with respect to the total ceiling area, has a minimum convective energy loss for the obvious reason that air heated by the panel tends to rise, presses—in effect—against the heating surface, and hence does not tend to circulate. The velocity of air across the heating surface is therefore low and the film coefficient of heat transfer by convection has been shown experimentally to have an average value of approximately 0.4 Btu per hr per sq ft of panel per 1 F temperature difference between the panel surface temperature and the air temperature. Actually, the film coefficient varies as the one-fourth power of the temperature difference and varies also with the character of the panel surface, but for practical design purposes the assumption of a constant value of 0.4 is accurate within the limits of error which exist in such structural constants as are used in calculating the heat load.

When the heating surface is moved from the ceiling to the wall the air that comes in contact with the panel is heated, tends to rise, and thereby establishes a velocity across the face of the panel with a consequent increase in the convective coefficient of heat transfer to a value of approximately 0.8 Btu per hr per sq ft per F. For a floor panel, an even greater circulation is set up as the heated air tends to move directly away from the surface rather than, as for the wall, parallel to it; the convective film coefficient for a floor surface can be taken as approximately 1.1 Btu per hr per sq ft per F.

Comparison of the convective film coefficients for floor, wall, and ceiling (1.1, 0.8, and 0.4, respectively) shows at once that a floor panel is primarily a convector since it dissipates by convection 275 per cent as much energy as does a ceiling panel operating at the same surface temperature. A wall panel also has marked convector characteristics, since it dissipates 200 per cent as much energy by convection as does a ceiling unit at the same surface temperature. As a very rough approximation, it follows that the rates of energy dissipation by convection from ceiling, wall, and floor panels (at the same surface temperature) can be taken, respectively, as in the ratio of 1 to 2 to 3.

A Frequently Misinterpreted Fact

Energy dissipation by radiation is a surface and surround phenomenon which has no relationship with the aspect (position) of the heated surface. Thus for a given range of surface temperatures an equivalent film coefficient of radiant transfer can be established which will be valid for a heating surface irrespective of its location. For the temperatures usually maintained in comfort heating installations the equivalent radiation coefficient can, with adequate accuracy, be taken as 1.0, thereby giving total energy dissipation coefficients for ceiling, wall, and floor panels of 1.4, 1.8, and 2.1 Btu per hr per sq ft per F, respectively. Thus — for surfaces at the same temperature—a wall panel dissipates 30 per cent more

NICE WAY TO MAKE A LIVING, being a press agent. The one who sent us this picture says that Shakespeare's famous witches' brew—produced with bubble, bubble, toil and trouble—was pure consomme compared with the concoction Ruth Ott, of the Minneapolis-Honeywell Regulator Co., is stirring in this surrealistic conception of how thermostats are made. This really isn't the way thermostats are put together, he says, but the fascinating witch actually has some of the oddest of the 2000-odd ingredients here, including calf skin skivers.

energy than a ceiling panel, whereas a floor panel dissipates 50 per cent more energy than a ceiling panel.

This fact has frequently been misinterpreted as indicating that a floor panel has a greater dissipating capacity and hence will require less surface; if the design surface temperatures were the same for all three locations such an interpretation would be correct, but actually —as will be shown — the much lower design temperature of the floor surface reduces the capacity of a floor panel to about one-half that of a ceiling unit of equal area.

How to Approximate Panel Ratings

The exact rating of 1 sq ft of panel heating surface can be evaluated only in terms of the particular installation. In a room with 65 F air and 75 F mean radiant temperature, the effective comfort temperature will be the arithmetical average, 70 F, but this value cannot be used in calculating energy dissipation from the panel for two reasons: (1) the average temperature of the surfaces which are "seen" by the panel is less than the mean radiant temperature, and (2) the convective and radiant fractions of the equivalent overall film coefficient are not equal, hence an arithmetical average of air temperature and surround temperature is not valid.

For approximate comparison, however, the two factors mentioned above can be neglected and the relative capacities of floor, wall, and ceiling panels evaluated in terms of design surface temperature, equivalent comfort temperature (taken as 70 F), and overall equivalent film coefficient. Arbitrarily taking 1 sq ft of ceiling panel at a surface temperature of 120 F as a standard it is then readily possible to calculate the amount of floor or wall surface, at any selected surface temperature, which would dissipate an equal quantity of energy.

As an example consider a floor panel operating at 85 F surface temperature; the area of such a panel which would produce a heating effect equivalent to that of 1 sq ft of 120 F ceiling panel is $[(120—70)\times1.4] \div [(85—70)\times 2.1]=2.22$ sq ft. Table 1 summarizes the equivalent areas similarly determined for most of the panel design conditions which are ordinarily used in practical installations.

Examples Illustrate Use of Table 1

Example 1: Design calculations for a 120 F ceiling panel installation show that 120 per cent of the ceiling area would have to be heated. Since "difficulty" would arise in heating the 20 per cent of the ceiling that does not exist, some means must be found for providing supplementary wall or floor panels equal in capacity to 20 per cent of the ceiling area. Assume that the designer chooses to use supplementary wall panels at a design surface temperature of 100 F. Entering part *A* of Table 1, read 1.30 as the correction coefficient, thereby indicating that 1.30×20 per cent=26 per cent of the ceiling area as the necessary size of the supplementary wall panel.

Example 2: A floor panel design shows the need for 250 sq ft of 85 F heated floor surface in a room where bookcases and other interferences reduce the available surface to 200 sq ft. The designer chooses to supplement the floor unit with a ceiling panel at a surface temperature (for maximum load) of 100 F. Entering part *F* of Table 1, read 0.76 as the correction coefficient giving, therefore, 0.76×50 =38 sq ft of ceiling required for the supplementary panel.

Example 3: A 100 F ceiling design indicates the need for a panel area equal to 120 per cent of the ceiling area. If the design temperature were raised to 120 F, would the requisite area be reduced sufficiently to permit installation in the ceiling? Going to part *B* of Table 1, read 0.60 as the correction coefficient, giving 0.60×120=72 per cent of the ceiling as an adequate panel size.

These three examples illustrate three different uses for the approximate relationships of Table 1. Whenever using this table, however, it should be remembered that it is based on assumptions which are not exact; when the fraction of surface to be converted from one plane to another is small the error resulting from use of the tabular coefficients will likewise be small, but in cases where the area to be converted is a large part of the total panel area the use of the coefficients may lead to serious error.

In no case should the tabular values be used in basic design; their purpose is to simplify minor modifications that may be required in a design which has been carried out by the usual methods, and when so used the results will be accurate well within the limits of accuracy of the basic design coefficients.

Aside from the *quantity* of energy dissipated by various types of panels, consideration should also be given to the *quality* of such energy.

Table 1—Summary of equivalent areas for floor, wall, and ceiling panels for most design conditions used in practice

A. To convert a known area of 120 F ceiling panel to equivalent area of some other type of panel, multiply the known area by the coefficient selected from this table:

Surface Temperature	Ceiling Panel	Wall Panel	Floor Panel
85°	***	***	2.22
100	1.67	1.30	1.11
120	1.00	0.78	***

B. To convert a known area of 100 F ceiling panel to equivalent area of some other type of panel, multiply the known area by the coefficient selected from this table:

85°	***	***	1.33
100	1.00	0.78	0.67
120	0.60	0.47	***

C. To convert a known area of 120 F wall panel to equivalent area of some other type of panel, multiply the known area by the coefficient selected from this table:

85°	***	***	2.84
100	2.14	1.67	1.42
120	1.28	1.00	***

D. To convert a known area of 100 F wall panel to equivalent area of some other type of panel, multiply the known area by the coefficient selected from this table:

85°	***	***	1.71
100	1.29	1.00	0.86
120	0.77	0.60	***

E. To convert a known area of 100 F floor panel to equivalent area of some other type of panel, multiply the known area by the coefficient selected from this table:

85°	***	***	2.00
100	1.52	1.08	1.00
120	0.90	0.70	***

F. To convert a known area of 85 F floor panel to equivalent area of some other type of panel, multiply the known area by the coefficient selected from this table:

85°	***	***	1.00
100	0.76	0.59	0.50
120	0.45	0.35	***

As already pointed out, the radiant dissipation rate of a surface is independent of its position, but the convection dissipation rate increases progressively as the surface is moved from the ceiling to the wall to the floor. Thus the fraction of energy transfer by radiation is greatest for a ceiling panel (72 per cent), less for a wall panel (56 per cent) and least for a floor panel (48 per cent). In consequence, a ceiling panel comes closest to realizing the energy characteristics of a true radiant system, whereas a floor system—whatever other advantages it may possess—does not differ appreciably in its operating characteristics from a conventional type of convection heating system.

Probably the most significant criterion for use in estimating the effectiveness of *radiant* heating is the equilibrium value of the air temperature depression below the mean radiant temperature of the room. Fig. 1, taken from an ASHVE research report*, shows the depression for a given room under given conditions as a function of the convective fraction of the total equivalent film coefficient of heat transfer. Specific points on the curve identify the three types of panels under consideration and it is immediately evident that only a negligible depression is associated

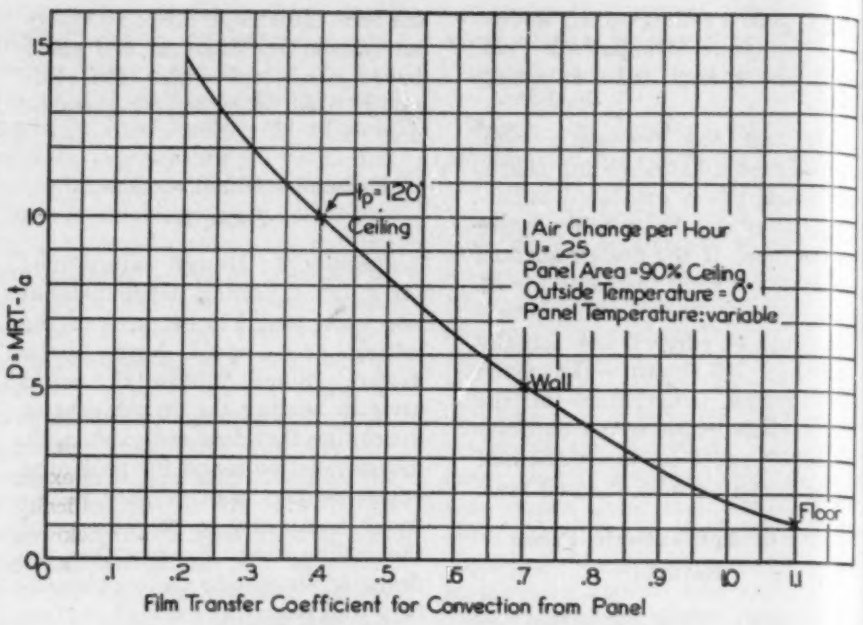


Fig. 1—Panel effectiveness vs. panel location

with a floor panel system. As stated in the paper from which Fig. 1 is taken, "A well designed floor panel installation may equal in performance a convection heating system and may possess other advantages which justify its use, but it does not in any marked degree possess the characteristics which are said to be desirable in radiant panel heating."

The only type of structure in which floor panels have a genuine *radiant advantage* over ceiling units is one in which the ceiling is unusually high. When this is the case, the shape factor of a given ceiling area with respect to the occupant is so much less than that of an equivalent floor area that a floor installation will be much more effective in raising the mean radiant temperature—measured with respect to the occupant or with respect to a unit sphere at the breathing level—than will a ceiling installation. Irrespective of ceiling height, however, a wall installation with panel surface located in the lower 16 ft of wall will be more effective than a floor installation except in unusually large (exceeding 40 ft in length or width) rooms.

*Trend Curves for Estimating Performance of Panel Heating Systems, by B. F. Raber and F. W. Hutchinson, ASHVE Transactions, Vol. 48, 1942, pages 425-436.

Heir Conditioner

A machine to mind the baby has been developed. The device is essentially an air conditioned crib designed to provide optimum conditions for the baby and to minimize the problem of child care. The crib, first described in the Ladies' Home Journal, was developed by Dr. B. F. Skinner, professor of psychology at Indiana University.

The basic design of the crib is simple—a cabinet which occupies about the same floor space as an ordinary crib. Its mattress is a removable frame of hard wood over which a duck covering has been shrunk. A one week's supply of sheet is fed from a compartment at one end of the crib, over the mattress, and out into a ventilated compartment. When the portion of the sheet on the mattress becomes soiled, a simple lock is released and a fresh portion of sheet is pulled through. To keep the baby warm without any restraining clothing or covers, the air is heated by an ordinary light bulb housed in an insulated compartment in the base of the cabinet. Air, drawn by convection through a filter which is claimed to remove 90 per cent of household dust and 97 per cent of the larger pollens such as ragweed, is heated and distributed by a baffle to the space under the mattress. Humidity is controlled by passing the heated air over a wick which is adjustable by hand. The air exhausts from the baby's living space through a screened opening in the ceiling, around another baffle and out. A thermostat regulates the air temperature within 1 deg and operates a warning buzzer if the temperature varies 2 deg. In summertime, a small blower is installed; a temperature drop turns the blower off and starts the heating system. At high temperatures, a tray of ice cubes at the air intake is said to contribute to the baby's comfort.—From the Industrial Bulletin of Arthur D. Little, Inc.

Pipe Wall Thickness Based on Total Combined Stress

Otis W. Page Develops Formula for More Logical and Rational Determination of Thickness of Pipe

IN SELECTING the pipe wall thickness for a new piping installation, the designer is required to meet the minimum rules of various regulatory bodies. The formulas used by these bodies have always been modifications of the Barlow formula for bursting or hoop stress. While all those dealing with the subject have realized that under high temperature conditions other stresses existing in a piping system were far more critical than the bursting stress, no direct recognition of their values has been taken. This situation has led to much discussion as to the proper wall thickness. Many designers have felt that because of the high factor of safety on bursting stress, the pipe wall is usually too thick. At the same time, no formula showing a combined factor of safety has been offered to show that the pipe can be thinned out.

The author is one of those who, for many years, has felt that for high temperature conditions the pipe wall is usually too thick. In developing that idea and in arriving at a logical basis for selecting the thickness, there has been prepared a formula combining the effect of the six major stresses existing in the pipe to provide an overall factor of safety consistent with presently accepted design practice.

The results of the formula developed here are somewhat surprising, but they appear rational and answer a number of questions raised from time to time in the literature on pipe stress.

The formulas used by regulatory bodies are shown in Table 1. Coast Guard and American Bureau of Shipping rules conform to the American Standards Association, with variations in constants.

Factors of Safety

The allowable working stress is selected from tables supplied by the regulatory bodies, and contains a factor of safety of approximately 4.0 to 8.0 on the yield strength. These, however, are minimum thicknesses and are required to be increased for the thinning out of the pipe wall in bending. The exact requirements are not specifically stated for the increased thickness for bending, and so the final factor of safety varies widely in practice —from 6.0 to 10.0.

In the 1939 proceedings of the Society of Naval Architects and Marine Engineers, Professor William Hovgaard, one of the foremost authorities on this subject, suggested a factor of safety of 6.0 for a five-diameter bend.

Opposition to Use of Formulas

Opposition to the use of these formulas for high pressures and temperatures is based upon the fact that an unjustified thickness (unnecessary from a strength point of view) makes the design problem more difficult; could be dangerous by increasing the reactions on anchorage points at turbines, boilers, or bulkheads, and makes the installation problem more difficult—with practically no benefit in reduction of stress. It is contended that these formulas are irrational, since they neglect entirely the maximum stresses existing in the pipe, which are due to expansion; and that they are illogical, since the maximum stresses due to expansion are almost entirely independent of thickness and pressure, while the present formulas vary the thickness directly with pressure.

Expansion Stress Formulas

The expansion stress formulas used for piping are made up of variations of the simple cantilever beam formula. To illustrate the above statement, we may consider a simple cantilever beam:

$$\Delta = \frac{FL^3}{3EI}$$

or

$$FL = \frac{3EI\Delta}{L^2}$$

In pipe lines, for a given length, the expansion, which is the deflection in the above formula, will be the same regardless of the thickness of the pipe. Any change in thickness would only vary the moment of inertia, I. Hence, the bending moment, FL, will increase directly with the moment of inertia, I.

But the stress is equal to

$$\frac{FLr}{I} = \frac{3EI\Delta r}{L^2 I} = \frac{3E\Delta r}{L^2}$$

The moment of inertia cancels out and the stress is seen to be ex-

MANY PIPING engineers have felt that, for high temperature conditions, the pipe wall as determined by procedures of various regulatory bodies is too thick. It would appear that the C factor and the thinning out factor for bending are supposed to take care of a great many unknowns, the principal unknown being the expansion stress, which is entirely neglected. It is not surprising then, to read of the permanent set which a piping system takes when first put into service. The author suggests in this article that the thickness of pipe walls may be much more logically and rationally obtained by using the formula developed herein with a minimum thickness of 0.10 in., adding only the mill tolerance of 12½ per cent to the calculated thickness and selecting the nearest larger commercial thickness to take care of thinning out of the pipe in bending. . . . Mr. Page is the chief of engineering plan approval of the New Orleans construction office of the United States Maritime Commission.

Table 1—Formulas for pipe wall thickness used by regulatory bodies

Barlow (Thin Wall)	Lamé (Thick Wall)	American Standards Assn.	Lloyds
$t = \frac{Pd}{2S_{pt}}$	$= \frac{d}{2} + \sqrt{\frac{S_{pt} - P}{S_{pt} + P}}$	$= \frac{Pd}{2S_{pt}} + C$	$= \frac{Pd + 1440}{2P + 12000}$

P = working pressure, psi;
t = pipe wall thickness, in.;
S = stress in pipe wall as indicated by subscripts, psi;
d = outside diameter, in.;
r = outside radius, in.;
F = force, lb;
Δ = deflection, in.;
L = length, in.;
E = modulus of elasticity, psi;
Y = yield strength, psi;
M = bending moment as indicated by subscripts, in.-lb;
β = longitudinal stress factor (Hovgaard-Jenks);
γ = transverse stress factor (Hovgaard-Jenks);
λ = (or h) stress parameter (Hovgaard);
K = rigidity factor (Hovgaard-Jenks);
R = radius of bend, in.;
I = moment of inertia, in.^{4};
1, 2, 3 = subscripts indicating plane of bending moment;
1, t, s, p = subscripts indicating longitudinal, transverse, shearing, or pressure stress;
x = reciprocal of factor of safety on yield strength.

This list of symbols will be used throughout this discussion.

Table 2—The moments shown in Fig. 1, in combination with pressure, develop six principal stresses which are combined to give the total combined stress

Stress Plane	Longitudinal	Transverse	Shear
XY	$S_{l1} = \frac{\beta M_1 r}{I}$	$S_{t1} = \frac{\gamma M_1 r}{I}$	
XZ	$S_{l2} = \frac{M_2 r}{I}$		
YZ			$S_s = \frac{M_3 r}{2I}$
Pressure:	$S_{p1} = \frac{P\left(1 - \frac{t}{r}\right)^2}{1 - \left(1 - \frac{t}{r}\right)^2}$	$S_{p1} = \frac{P\left[1 + \left(1 - \frac{t}{r}\right)^2\right]}{1 - \left(1 - \frac{t}{r}\right)^2}$	

These stresses may be combined.

$$S_1 = \sqrt{\left(\frac{\beta M_1 r}{I}\right)^2 + \left(\frac{M_2 r}{I}\right)^2} + S_{p1}$$

$$= \sqrt{\beta^2 + \left(\frac{M_2}{M_1}\right)^2}\,\frac{M_1 r}{I} + S_{p1} \qquad S_t = \frac{\gamma M_1 r}{I} + S_{p1} \qquad S_s = \frac{M_3 r}{2I}$$

The total combined stress becomes:

$$S = \sqrt{S_l^2 + S_t^2 - S_l S_t + 3S_s^2}$$

or $$xY = \sqrt{(x_l Y)^2 + (x_t Y)^2 - x_l x_t Y^2 + 3(x_s Y)^2}$$

and the reciprocal of the factor of safety may be expressed

$$x = \sqrt{x_l^2 + x_t^2 - x_l x_t + 3x_s^2}$$

This formula may be rearranged:

$$\sqrt{x^2 - 3x_s^2} = \sqrt{x_l^2 + x_t^2 - x_l x_t}$$

actly the same regardless of thickness, and the pressure has not been involved at all.

If we apply the same reasoning to a pipe bend involving the use of the Hovgaard or Karman K value, we may find (for certain conditions) an *increase* of thickness will *increase* the expansion stress. While the stress formulas show this condition, the author is not yet convinced of its truth and would prefer, until a more thorough investigation of the value of K has been completed, to say only that the stress is not reduced by an increase in thickness.

Formula Based on Total Combined Stress

That the present thickness formulas neglect entirely the maximum stresses has been pointed out repeatedly, and it has been frequently suggested that a formula based on total combined stress should be used.

In order to arrive at a factor of safety, the formulas to be used in calculating the total combined stress must be defined. The generally accepted method is that devised by Hovgaard and modified by Jenks.

For a three-plane piping system, we find three moments exist at each point in the pipe line, as shown in Fig. 1. These moments, in combination with the pressure, develop six principal stresses which are combined to give the total combined stress, as shown in Table 2.

The right-hand side of the last expression in Table 2 represents the combined factor of safety for a single-plane problem. If maximum values of x_l and x_t are selected, the combined stress in a single plane is set.

The value of x_l selected will also control the longitudinal bending stress in a three-plane problem since these bending stresses are added vectorially. The transverse stress in a three-plane problem will be reduced since its value is a function of the bending moment in one plane only. The only remaining stress is the shearing stress.

If the value of x_s is now selected, the value of x may be determined for the three-plane problem, so that the thickness which is selected on a single-plane basis will be ample

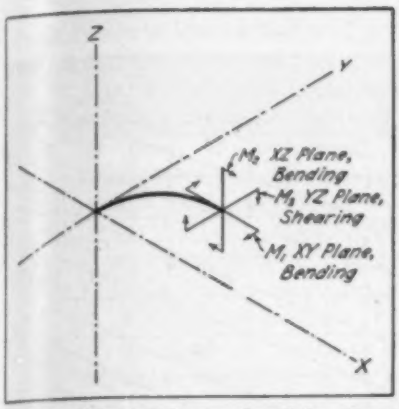


Fig. 1—Ninety degree bend in plane XY

for any three-plane condition. It will only be necessary to define for the designer the maximum value of x_1 and x_2.

Since the thickness is to be selected on a single plane basis, M_2 and $M_3 = 0$, and

$$S_1 = x_1 Y = \frac{\beta M_1 r}{I} + P\frac{\left(1-\frac{t}{r}\right)^3}{1-\left(1-\frac{t}{r}\right)^3}$$

$$S_t = x_t Y = \frac{\gamma M_1 r}{I} + P\frac{1+\left(1-\frac{t}{r}\right)^3}{1-\left(1-\frac{t}{r}\right)^3}$$

or

$$\frac{\beta M_1 r}{I} = x_1 Y - \frac{P\left(1-\frac{t}{r}\right)^3}{1-\left(1-\frac{t}{r}\right)^3}$$

$$\frac{\gamma M_1 r}{I} = x_t Y - P\frac{1+\left(1-\frac{t}{r}\right)^3}{1-\left(1-\frac{t}{r}\right)^3}$$

Dividing $\frac{\gamma M_1 r}{I}$ by $\frac{\beta M_1 r}{I}$

$$\frac{\gamma}{\beta} = \frac{x_t Y - P\dfrac{1+\left(1-\frac{t}{r}\right)^3}{1-\left(1-\frac{t}{r}\right)^3}}{x_1 Y - P\dfrac{\left(1-\frac{t}{r}\right)^3}{1-\left(1-\frac{t}{r}\right)^3}}$$

This expression may then be reduced to:

$$\frac{P}{Y} = \frac{\left(x_t - \frac{\gamma}{\beta}x_1\right)\left[1-\left(1-\frac{t}{r}\right)^3\right]}{1+\left(1-\frac{t}{r}\right)^3 - \frac{\gamma}{\beta}\left(1-\frac{t}{r}\right)^3}$$

It can be seen that for the allowable values of x_t and x_1, P/Y is determined for any t/r and γ/β. But γ/β depends on t/r and R/d; therefore, for any t/r and R/d the permissible P/Y may be determined. This formula provides then a thickness criterion for the single-plane problem.

The use of the formula may be more easily illustrated by selecting factors of safety and applying them to a curve of P/Y vs. t/r.

x_1: Professor Hovgaard has recommended an allowable cold carbon stress of 20,000 psi, approximating an x_1 value of $\frac{2}{3}$. Maritime Commission specifications have generally required a maximum value of $x_1 = 0.70$. These values have often been exceeded in actual installations. A value of $x_1 = \frac{2}{3}$ should be reasonable.

x_2: Allowable shearing stress is usually considered as $\frac{1}{2}$ of the allowable tensile stress. x_2 can, therefore, reasonably be taken at $\frac{1}{3}$.

x_t: It was because of the unknown nature of the transverse stresses that Professor Hovgaard recommended a high factor of safety on the usual thickness formulas. However, as he has stated, these transverse stresses in many cases far exceeded the yield strength and plastic flow relieved the surface stress until the full strength of the pipe wall became effective. It would appear that almost any value of x_t below 1.0 would be better than present formulas provide.

Assuming $x_1 = 0.667$ and $x_2 = 0.333$, and substituting in the expression for x, we obtain

$$x = \sqrt{0.778 + x_t^2 - 0.667x_t} \quad \text{(3-plane)}$$

$$= \sqrt{0.444 + x_t^2 - 0.667x_t} \quad \text{(1-plane)}$$

Fig. 2 shows a plot of these values. It can be seen that variations in the value of x_t have relatively little effect on the total combined stress where maximum values of x_1 and x_2 exist. With a three-plane installation, the value of M_1 would have to be reduced, because M_2 adds to the longitudinal stress, and the transverse stress dependent on M_1 would be proportionally reduced. Accordingly, the author has arbitrarily assumed a value of $x = 0.95$ corresponding to $x_t = 0.815$. While these values may sound high, they are much more rigid than are in general use where no restrictions exist.

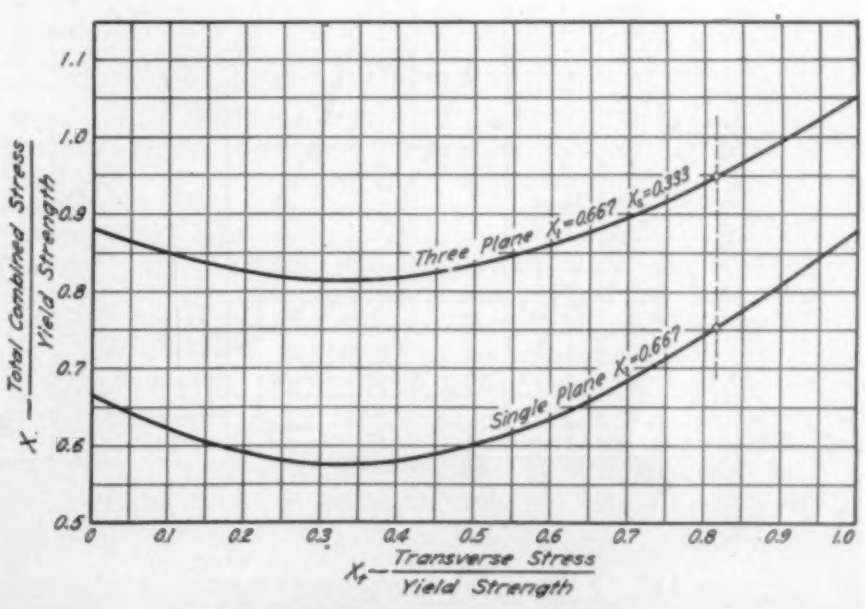


Fig. 2—Reciprocal of factor of safety

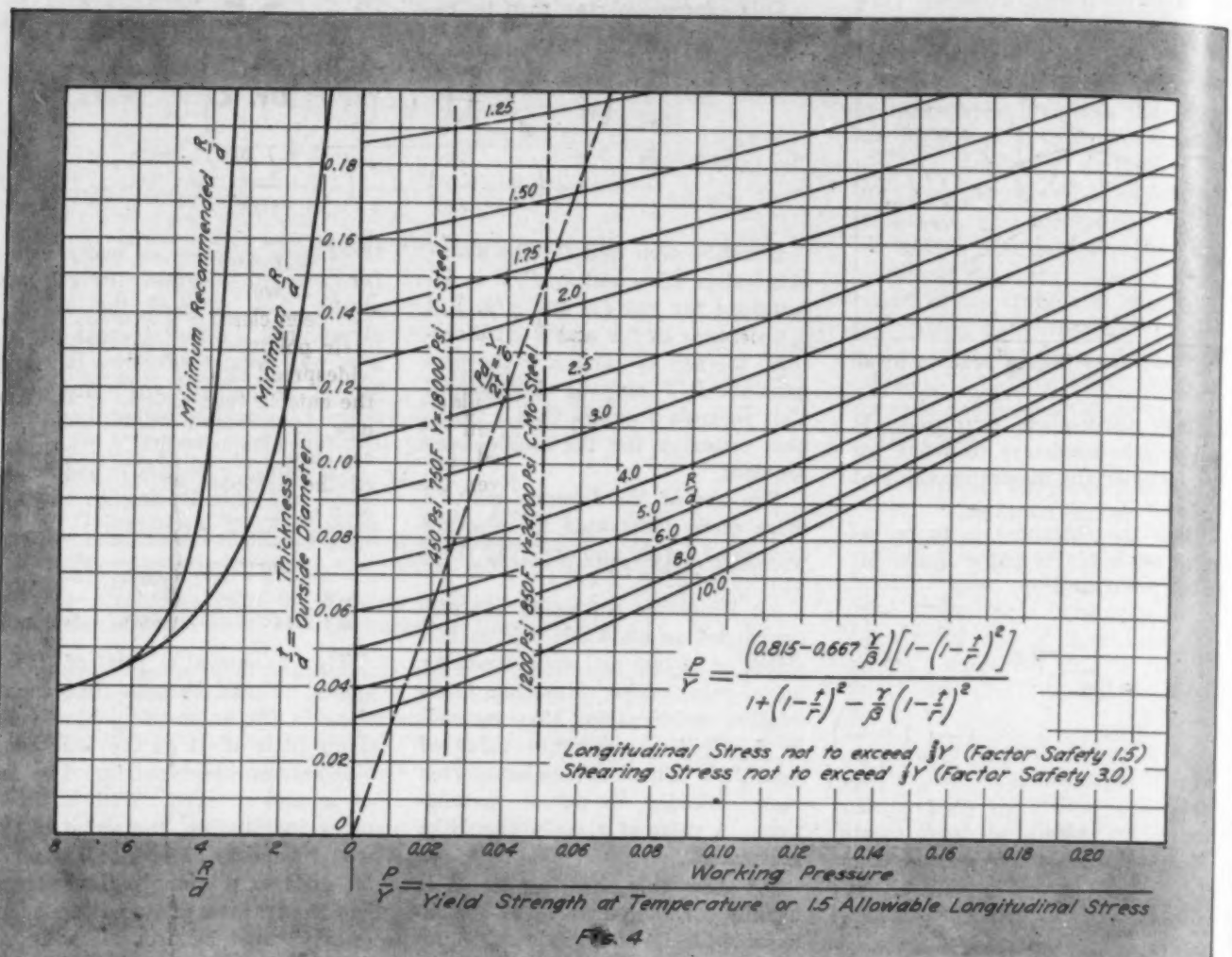

Minimum Recommended R/d
Minimum R/d
Thickness / Outside Diameter = t/d
1.25
1.50
1.75
2.0
2.5
3.0
4.0
5.0
6.0
8.0
10.0
450 Psi 750F Y=18000 Psi C-Steel
1200 Psi 850F Y=24000 Psi C-Mo-Steel
Pd/2t = Y/6
P/Y = (0.815 − 0.667 Y/β)[1 − (1 − t/r)²] / 1 + (1 − t/r)² − Y/β (1 − t/r)²
Longitudinal Stress not to exceed ⅓Y (Factor Safety 1.5)
Shearing Stress not to exceed ⅓Y (Factor Safety 3.0)
R/d
P/Y = Working Pressure / Yield Strength at Temperature or 1.5 Allowable Longitudinal Stress

Fig. 4

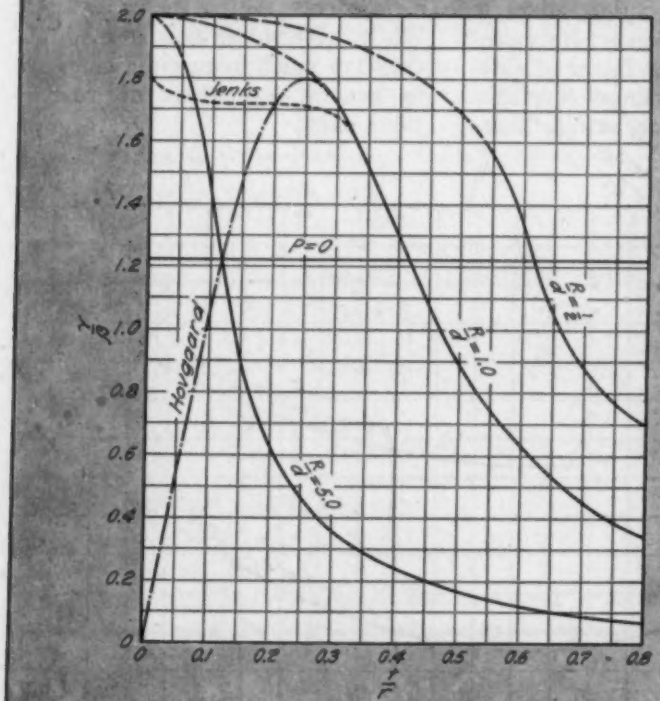


Fig. 3

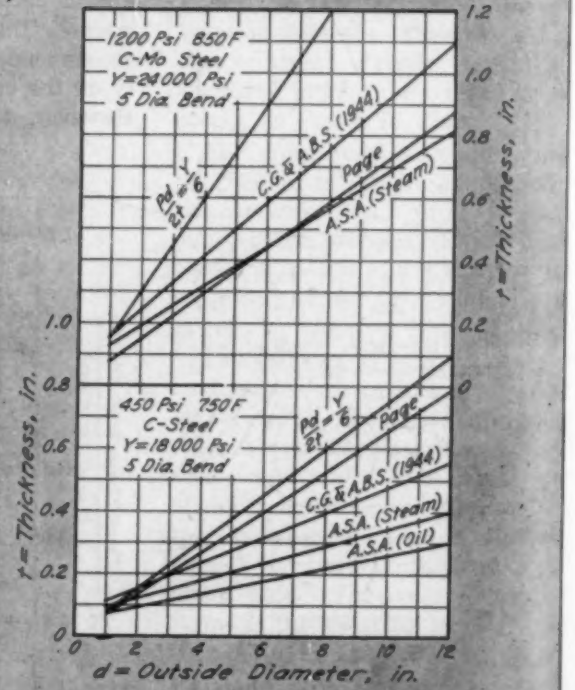


Fig. 5

Fig. 3 shows the variation of γ/β with t/r. The Hovgaard values of $\gamma/\beta = 0$ for $\lambda = 0$, while the Jenks values appear to go to 1.8. It would seem the ratio of transverse to longitudinal stress should approach the limit of 2. If the pipe thickness is selected on the basis given above, however, this difference will be of no concern, for in the lower range of λ the thickness is less than is necessary to meet the factor of safety requirements; that is, it is determined by a γ/β value which will lie on that portion of the γ/β vs. t/r curve moving downward and to the right with increasing values of t/r.

Fig. 4 is a plot of the thickness required by the suggested formula with a total combined stress of 95 per cent of the yield strength.

The yield strength is a somewhat indeterminate figure when dealing with high temperatures. It may be desirable to base the allowable stress on proportional limit or creep stress. In any event, an allowable longitudinal bending stress must be selected and the value so selected is to be considered $\frac{2}{3}$ of this yield strength value.

A study of Fig. 4 brings out some rather glaring discrepancies. We have been selecting the wall thickness on the basis of an allowable bursting stress. In general, the regulatory bodies have required that this minimum thickness should be increased for bending, but the amount of increase for bending was not stated. The amount added has been for the purpose of taking care of the thinning of the outer wall. The thinning of the outer wall amounts to nothing when compared to the increase which should have been made for the increase in bending stress. For instance, the difference in thickness between a five-diameter bend and a three-diameter bend due to thinning would be about 6 per cent, but the difference required to obtain the same factor of safety is 53 per cent.

The present rules have been entirely inadequate for low pressures where even normal bends were used, except for small diameters, where the amount added to take care of corrosion and threading increased the thickness sufficiently to bring the calculated thickness above that required to take care of stress. Conversely, present rules require thicknesses far in excess of that necessary for higher pressures. This is obvious, since the rules increase thickness directly proportional to the pressure, when the greater portion of the stress is entirely independent of pressure.

These statements are aptly illustrated by Fig. 5, where various rule requirements are plotted for 450 psi, 750 F and 1200 psi, 850 F, together with the thickness as calculated by the author's formula with a constant factor of safety.

The thickness added for corrosion is another problematical figure. On Fig. 5 are plotted the ASA requirements for oil piping at 450 psi and 750 F. Oil piping is permitted to be thinner than steam piping and the corrosion factor is less than for steam. This is exactly opposite to what would be expected and is opposite to the requirements of the Coast Guard and the ABS. The steam line, for high pressure systems, carries steam made from highly distilled water which has been deaerated and treated to prevent corrosion, and steam is used as a fire extinguisher. The oil, however, is above the flash point and a break would definitely produce a fire. Also, corrosive elements are present in oil.

OPPOSITE

Fig. 3—Relationship between γ/β and t/r

Fig. 4—Pipe wall thickness based on total combined stress (longitudinal, transverse, shear)

Fig. 5—Comparison of thickness using American Standards Association, Coast Guard, American Bureau of Shipping, and the author's methods

ATMOSPHERIC SEWAGE

Air Pollution Problem Should Be Considered on Health Basis Alone, Says Dr. C. A. Mills

THERE EXISTS a highly significant relationship between atmospheric pollution (sootfall) and respiratory disease death rates in the various districts of Cincinnati and Pittsburgh, says Dr. Clarence A. Mills, in summarizing his paper on Smoke and Health, published in the July 1945 Rhode Island Medical Journal. This hazard involves particularly the men living and working in the badly polluted industrialized districts of the two cities. Even the females of these districts show much more respiratory disease than is found in the hilltop suburbs, but the male rates rise two to three times more than the female, he states.

Little difference between male and female rates exists in the suburban areas of these two cities or among rural residents of Ohio.

Exhaust steam from power sources adds greatly to the winter smoke problem by remaining as a fog to hold the flue products suspended in the air people must breathe, according to Dr. Mills.

Remedial steps should include: (a) use of low volatile coal or proper equipment to burn high volatile varieties smokelessly; (b) effective trapping of fly ash in chimney or stack; (c) preliminary washing of high sulphur coals; and (d) use by the railroads of diesel or electric power within metropolitan limits.

A half-century ago city water supplies were purified only after it had been clearly demonstrated that their pollution was responsible for widespread sickness and death from the enteric fevers. And so we may now see earnest attempts at clarification of city atmospheres, in view of the evidence set forth. It will cost something for this elimination of air pollution, just as it did for water purification. It should be borne in mind, however, that disease itself is expensive, Dr. Mills points out. Respiratory diseases (including influenzal infections) account for about 70 per cent of the working time lost by employed persons on account of illness. A saving of even two such lost days a year for each employed person would probably pay the total cost of smoke clearance in any city.

The time has arrived, Dr. Mills believes, when the smoke problem should be considered on a health basis alone, without regard to the dry cleaning or laundry savings which would accrue from smoke elimination.

Reduces Use to 0.2 Lb Steam per Degree Day per 1000 Cubic Feet

Department Store Cuts Steam Cost from $15,000 to $10,000

REDUCTION over the period of the last few years in the amount of steam needed for heating the Gimbel Brothers store, Milwaukee, Wis., is an example of what can be accomplished along these lines by constant attention to details. The cost of steam for heating averaged —from 1932 to 1939—around $15,000 a year, but under the program of improvement and correction of bad spots in the heating installation, which has been carried on since 1939 under the direction of L. H. Dickelman, the maintenance superintendent, the annual steam bill now amounts to something like $10,000.

Last year, for example, 13,629,000 lb of steam was used in space and water heating. The building has a content of 9,200,000 cu ft. There was a total of 7076 degree days in the year. Steam is supplied from central station service at from 3 to 5 psi pressure. There is about 65,000 sq ft of equivalent direct radiation installed in the entire store, about half of it being served by subatmospheric steam and the other half by steam at above that pressure.

Constant attention to detail and improvement of the heating installation at the Gimbel store over a period of some years have paid off in worthwhile reductions in steam consumption and better heating results. Along the river side of the building, and projecting out over the river, is enclosed storage space called the "dock". This space is heated by means of hot condensate from various heating zones, the condensate being circulated through extended surface heating elements which are installed along the exterior wall and about 2 ft above the floor. These extended surface heating elements are connected end to end by use of pipe couplings and extend the entire 320 ft along the river front. Over 50 per cent of this frontage is heated with the use only of condensate, but some live steam is used in the balance of the space during severe weather. Having performed this heating service, the condensate then passes through the condensate meters before it is discharged to the river.

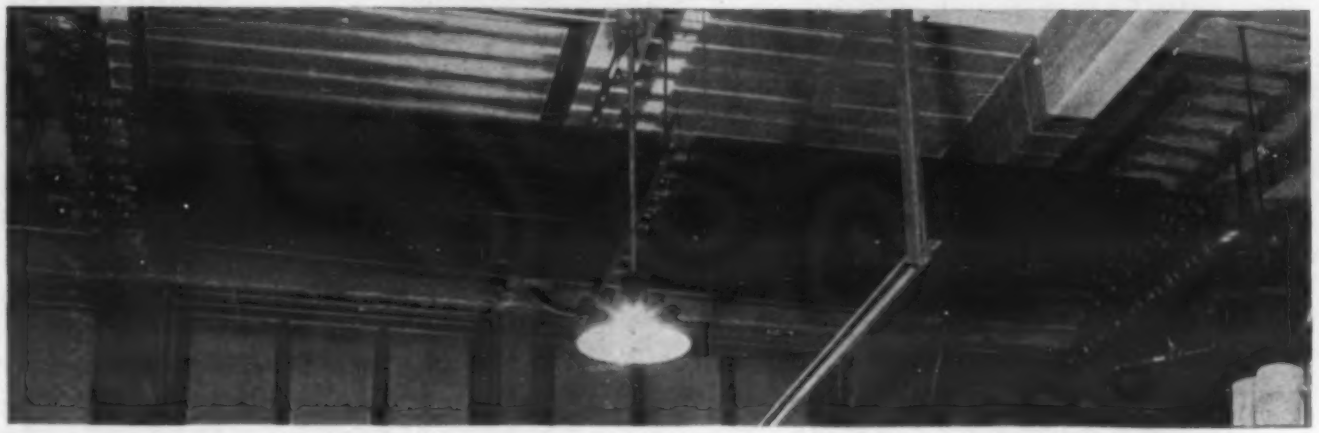
Close Cooperation Between Owner and Contractor

This heating improvement program is also an example of close cooperation between the owner's representative and an independent contractor. Practically all of the contracting work at the store in recent years has been done by Harry W. Grosjean, who is a licensed professional engineer of Juttner Heating Company, Inc., contracting engineers in Milwaukee. Mr. Grosjean employs 11 steamfitters the year around, and confines himself to industrial and commercial work.

Typical of such work is a current project at the Gimbel store, where

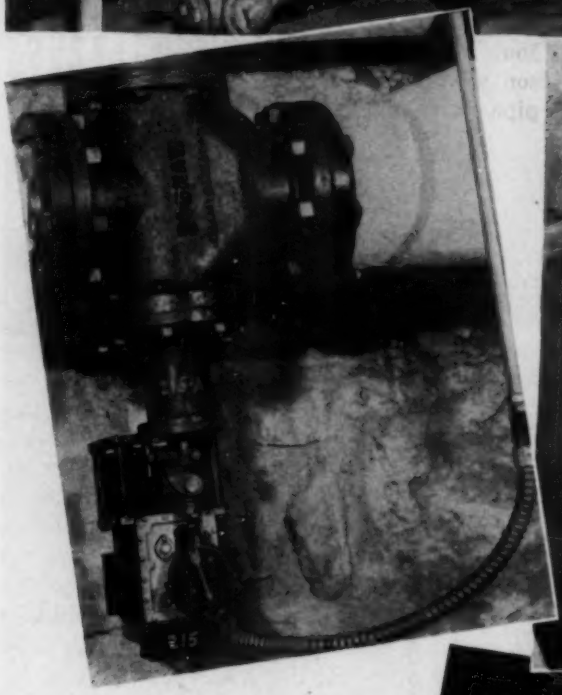
WEEKLY LOW AND HIGH PRESSURE STEAM CONSUMPTION

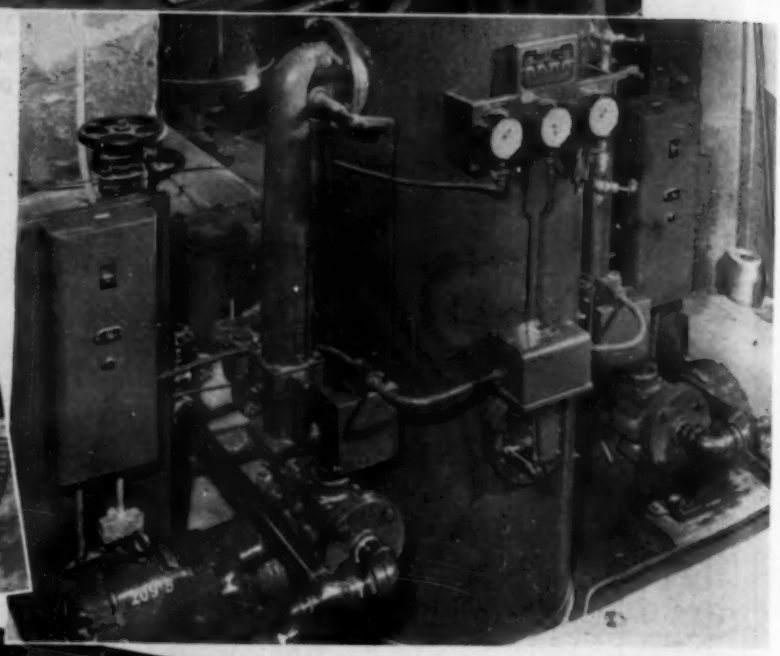
Date	MONDAY / /				TUESDAY / /				WEDNESDAY / /				THURSDAY / /				FRIDAY / /				SATURDAY / /				SUNDAY / /				Note
Temp.	13 Hour–Mean °				21 Hour – Mean °				24 Hour–Mean °				24 Hour–Mean °				27 Hour–Mean °				21 Hour–Mean °				38 Hour–Mean °				
Meter		Morning	Total Day	Night	Mon. Night	Morning	Total Day	Night	Tues. Night	Morning	Total Day	Night	Wed. Night	Morning	Total Day	Night	Thur. Night	Morning	Total Day	Night	Fri. Night	Morning	Total Day	Night	Sat. Night	Monday Morning			
F3																													
F8																													
F22																													
E77																													
D41																													
F29																													
F18																													
F28																													
D104																													
B206																													
D59																													
A88																													
B188																													
Total				Day		Night		Day		Night		Day		Night		Day		Night		Day		Night		Day					
				Pounds				Pounds				Pounds				Pounds				Pounds				Pounds					
Meter		Morning	Total Day	Night	Mon. Night	Morning	Total Day	Night	Tues. Night	Morning	Total Day	Night	Wed. Night	Morning	Total Day	Night	Thur. Night	Morning	Total Day	Night	Fri. Night	Morning	Total Day	Night	Sat. Night	Monday Morning			
F30																													
E41																													
Total				Day		Night		Day		Night		Day		Night		Day		Night		Day		Night		Day					
				Pounds				Pounds				Pounds				Pounds				Pounds				Pounds					
High Press.		Morning	Total Day	Night	Mon. Night	Morning	Total Day	Night	Tues. Night	Morning	Total Day	Night	Wed. Night	Morning	Total Day	Night	Thur. Night	Morning	Total Day	Night	Fri. Night	Morning	Total Day	Night	Sat. Night	Monday Morning			
				Pounds				Pounds				Pounds				Pounds				Pounds				Pounds					



Above—Complete records of steam consumption are kept on this form, which provides spaces for entering readings from all the meters for a week and totals for morning, entire day, and night use, for each day. These totals are then transferred to a monthly sheet, which also shows the preceding year's record. The aim is to beat that record in the current year; shaded markings in the daily record indicate where they failed to do that, and unshaded markings show where they beat the previous record of steam usage

At left—Extended surface heating as used in the "dock" is also installed around warehouse doors, to utilize the heat in the condensate from various heating zones serving other parts of the store. These coils operate "waterlogged" at all times; that is, they are always filled with condensate and do not receive steam





Top—After the condensate from the heating systems has been cooled in the finned heating surface serving storage and "dock" areas, and its heat has been utilized, it flows into an accumulator or surge tank such as shown here, and then through the condensate meters. It is discharged from the meters to the river. In some cases, the condensate flows from the finned heating surface through the indirect coil on a fan system before going to the accumulator tank, meters, and discharge to the river

Center and right—A major part of the heating modernization program has been the installation of zoned subatmospheric steam systems which give "differential" control of both the steam temperature and steam volume; thus, the range of vacuum is changed to meet varying changes in the weather and only a quantity of heat is furnished to the radiation to balance the heat loss from the building. These views show the centralized control panels for three separate zones. One control panel regulates the two-pipe differential system, and the other control panels regulate the one-pipe steam systems operating above atmosphere pressure at all times. Balancing of distribution to the different heating units and radiators is accomplished by orifice regulating plates installed in inlet valves

snow-removing floor grilles have been installed in the entrance vestibules. Customers step in through the outer doors from the sidewalk onto open iron grille work. About 6 in. under the grille work is a metal pan under which are serpentine coils of wrought iron pipe, heated by steam to maintain a temperature of around 140 deg. Snow from the feet will fall through the grille work and be melted in the pan, the water running off to a drain.

Attention to Details

Such details as the time that heat is supplied to the different building zones—to assure that it will not be left on longer than necessary—are given careful consideration, and the operating routine provides for reduced indoor temperatures at nights, Sundays, and holidays. Comfort temperature levels are secured by the time the doors are opened in the morning because of a very rapid heating-up period.

In the warehouse space, timers allow heat to be supplied up to a maximum period of 55 min, after which it is again necessary to set them to continue heating service. This prevents the heat being turned on and forgotten and, therefore, being used when it is not really needed.

In our interview with Mr. Dickelman, he emphasized the fact that the steam consumption record of 0.2 lb per degree day per 1000 cu ft, as compared to the figure of 0.385 in the 1945 ASHVE Guide (an actual average from a survey of department stores) was exceedingly gratifying to the management as the economy in operation had also brought a much higher degree of comfort to their workers and customers. He pointed out also that it had been just as easy to fill the entire radiation completely—even to the farthest removed radiators from the central station supply valve—as it had been formerly with pressure steam.

YOUR RED CROSS
MUST
CARRY ON!
GIVE

"OPEN FOR DISCUSSION"

Readers Ask for Extra Copies of Pipe Specification Article

THE EDITOR—I would like to add my long overdue thanks to the many others you must have received for the fine article by Sabin Crocker on specifications for steel pipe, which appeared in the January issue of Heating, Piping & Air Conditioning. This article answers a lot of questions which are being asked every day and we feel it should be in the hands of every person who has anything to do with pipe design.

I wonder if it would be possible to buy 50 reprints of the article for distribution to the individual members of our district offices so that they can call special attention to it in their travels around the country.—G. W.

THE EDITOR—The January issue of Heating, Piping & Air Conditioning was received several days ago, and I was very much pleased to note that it contained Sabin Crocker's article, entitled Which Specifications for Steel Pipe Shall I Use? I beg to express to you and Mr. Crocker my appreciation for your efforts in preparing such an excellent article, which—as you both know—I feel is quite timely. . . . If you reprint the article, I should like to have about 10 copies for distribution among people in our organization here.—R. N. B.

THE EDITOR—I have read with interest the article by Sabin Crocker on specifications for steel pipe in the January HPAC, and would appreciate your advising whether or not it is possible to secure several reprints. If there is any charge, we, of course, will be glad to remit in the regular way.—H. R. R.

THE EDITOR—Please send us if possible 12 copies of the January issue of HPAC, or 12 reprints of the article, Which Specifications for Steel Pipe Shall I Use? by Sabin Crocker.—A. S. C.

THE EDITOR—Please quote net price, f.o.b. point, and shipping date for furnishing:

12 reprints of article, "Which Specifications for Steel Pipe Shall I Use?," which appeared in the January 1946 issue of Heating, Piping & Air Conditioning.

We are most particularly interested in reprint of pages 92 and 93, showing the consolidated table of chemical compositions, physical properties, and allowable stresses for steel pipe used for power piping, and would appreciate your advising if you can furnish reprints of the entire article.

A prompt reply will be greatly appreciated.—J. T. M.

Editor's Note—These requests are typical of a number which have been received for extra copies of Sabin Crocker's article on specifications for steel pipe, which was published last month and which features a two-page consolidated table of chemical compositions, physical properties, and allowable stresses for steel pipe. To meet these requests, planograph reprints of the article are being prepared and are available for 10c each. Address The Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Illinois.

BRITISH SHOW PROGRESS IN RE-HOUSING DRIVE

The British government's first statistical returns on the progress of its housing campaign show that by the end of January, 3469 permanent and 12,751 temporary houses had been constructed in England, Scotland, and Wales, according to Joan Littlefield, of the British Information Services.

In order to speed up its housing drive, the government has introduced a master plan for intensive production. It has three main points. First, the ministry of supply, dealing with industry direct, is placing bulk "blanket" orders for huge quantities of materials; second, standard designs will be mass produced, varieties of "fittings" being reduced to the minimum; third, bottlenecks in certain industries—caused by war paralysis—will be eliminated.

Suggests Combined Heating and Cooling for Apartments

THE EDITOR—I have read the article by H. B. Lammers on the air conditioning installation of the Wright Aeronautical plant, Lockland, Ohio, in the February issue. I was with Albert Kahn Associated Architects and Engineers, so I was involved in the engineering of this job and it includes some ideas of my own that are to some extent departures from the conventional and they have worked out very satisfactorily.

Large Savings Made

In the first place, others had calculated the air conditioning load on the original factory building, exclusive of the office building, at 6500 tons. However, I took a number of factors into account that others failed to recognize, such as the fact that temperature stratification in a building with a ceiling of this height means that there is very little differential between the air temperature in the upper part of the building and the outside air, hence very little transmission gain through the roof. The result was that I arrived at a load of only 5000 tons for the factory, which represented a saving of $450,000 in first cost.

In addition to the $450,000 saving, there was a saving of $600,000 due to the use of the combination heating and cooling system I advocated. In addition to these are many other obvious ones, such as saving in electric power transmission lines, saving in electrical generating equipment, etc. The savings on the system itself amount to more than $1,000,000. The total savings should amount to more than twice that figure.

My idea was to use a combined heating and cooling system in which hot water is circulated in the winter and chilled water in the summer so that the same fans, pumps, ducts, and piping are used both in cooling and heating service. All of the "experts" contacted condemned my scheme because of its alleged inflexibility in changing from the heating to the cooling cycle and back again during intermediate seasons and because they said that backheating was necessary in such seasons. I proposed methods of control that I was certain would avoid any such troubles. Since no flaws could be found in my figures and reasoning, my methods were adopted, but it was a tough battle.

Of course, I staked any reputation I might have on the results obtained by this installation. It is now a matter of record that the installation has been operating for several heating and cooling seasons and that it is completely satisfactory. This is borne out by Mr. Lammers' article.

Possible for Apartment Buildings

The reason I am so interested in the system used on the Lockland job and described in Mr. Lammers' article is that I am hoping to get the combined type of system recognized for use in apartment buildings. By using this type of system, along with some other ideas I have worked out, the cost of installing and operating air conditioning (including heating and cooling for all the year) can be brought down to a figure not much above the cost of a good heating system. Apartment house owners could not afford to be without it and it certainly would lead to a very great expansion of the air conditioning industry and greatly benefit apartment dwellers as well.—F. O. JORDAN, consulting engineer.

"OPEN FOR DISCUSSION"

ELECTRICITY GENERATION BY ATOMIC ENERGY "REMOTE"

"Ours is still a young and growing industry, and nothing now in sight can challenge its place," said Prentiss M. Brown and James W. Parker, in the annual report of the Detroit Edison Co. for 1945. "Atomic energy may some time be used in the production of electricity, but we believe it is fairly remote. From all we know now, atomic energy would be used as a source of heat in some special type of boiler, much as we now use coal. But even if we got atomic energy for nothing, our cost of serving the residence customer could not be much reduced because we burn less than a ton of coal a year to serve the average home.

"On the other hand," they said, "fuel is an important element of the cost of serving large commercial and industrial customers. If our present belief is correct, the rest of the electrical system—turbogenerators, transmission, motors, and other customer appliances—would not be changed as a result of the use of atomic energy. If and when atomic energy is applied to power production, we hope to be among the first to take advantage of it."

INCREASED COMMUNITY FACILITIES FOR HOUSING

Deferment of federal construction which would compete with veterans' housing for men and materials has been agreed upon by the interdepartmental committee on construction, which is composed of federal departments and agencies interested in construction, it was announced last month by Wilson W. Wyatt, national housing administrator and housing expediter.

At the same time, the committee gave its support to increased construction of community facilities necessary to the veterans' emergency housing program.

SIMPLIFIED REGULATING VALVES APPROVED

A proposed simplified practice recommendation covering automatic regulating valves, which was submitted to producers, distributors and users last November by the National Bureau of Standards, has been approved for promulgation effective on new business from April 1, 1946, according to the Department of Commerce. The purpose of the recommendation—R219-46—is to establish as a useful standard of practice in the industry a simplified list of pressure ratings and sizes of seven types of valves made of steel, iron, and bronze.

Mimeographed copies may be obtained without cost from the Division of Simplified Practice, National Bureau of Standards, Washington 25, D. C.

COMPARATIVE ENGINEERING DATA ON REFRIGERANTS GIVEN IN NEW TABLES

In deciding which refrigerant to use under a specific set of conditions, tables are needed which give engineering data such as weight and volume of refrigerant to be circulated per ton, and horsepower and capacity. Such tables, in addition to the basic data on thermodynamic properties, are of value in showing at a glance just which refrigerant would be desirable under a given set of circumstances.

For this reason various sets of tables* have been prepared for "Freon"-11, -12, -21, -22, and -113, ammonia, methyl chloride, and water vapor. These tables enable the user to make rapid comparisons of the important basic data needed in deciding whether a refrigerant is suitable for a given set of circumstances. Temperatures are shown in degrees Fahrenheit.

The tables are easy to use. The temperature of the liquid ahead of the expansion valve is equal to the condensing temperature if no subcooling takes place. However, a small amount of subcooling usually takes place in most condensers. It is reasonably safe to figure that the temperature of the liquid ahead of the expansion valve will be about 5 F lower than the actual condensing temperature. The actual condensing temperature corresponding to any given head pressure can, of course, be found in the tables for saturated liquid.

*See HPAC, June 1944, pp. 337-338, July 1944, p. 409, August 1944, pp. 478-480, October 1944, pp. 593-594, May 1945, pp. 256-258, and December 1945, pp. 616-618.

"Freon-21"—Theoretical capacity of refrigerating compressors
(Saturated vapor leaving evaporator)
Tons per cu ft per min of vapor compressed

Evap Temp	Temperature of liquid ahead of expansion valve													
	60	65	70	75	80	85	90	95	100	105	110	115	120	125
-20	0.0263	0.0260	0.0256	0.0253	0.0249	0.0245	0.0242	0.0238	0.0234	0.0231	0.0227	0.0223	0.0219	0.0216
-18	.0279	.0275	.0272	.0268	.0264	.0260	.0256	.0252	.0249	.0245	.0241	.0237	.0233	.0229
-16	.0296	.0292	.0288	.0284	.0280	.0276	.0272	.0268	.0264	.0259	.0255	.0251	.0247	.0243
-14	.0313	.0309	.0305	.0301	.0296	.0292	.0288	.0283	.0279	.0275	.0270	.0266	.0261	.0257
-12	.0331	.0327	.0323	.0318	.0314	.0309	.0305	.0300	.0296	.0291	.0286	.0282	.0277	.0272
-10	0.0351	0.0346	0.0341	0.0337	0.0332	0.0327	0.0322	0.0318	0.0313	0.0308	0.0303	0.0298	0.0293	0.0288
- 8	.0371	.0366	.0361	.0356	.0351	.0346	.0341	.0336	.0331	.0326	.0321	.0315	.0310	.0305
- 6	.0392	.0387	.0382	.0376	.0371	.0366	.0360	.0355	.0350	.0344	.0339	.0333	.0328	.0322
- 4	.0414	.0408	.0403	.0397	.0392	.0386	.0381	.0375	.0369	.0364	.0358	.0352	.0346	.0340
- 2	.0437	.0431	.0425	.0419	.0414	.0408	.0402	.0396	.0390	.0384	.0378	.0372	.0366	.0360
0	0.0461	0.0455	0.0449	0.0443	0.0436	0.0430	0.0424	0.0418	0.0412	0.0405	0.0399	0.0392	0.0386	0.0380
2	.0486	.0480	.0473	.0467	.0460	.0454	.0447	.0441	.0434	.0427	.0421	.0414	.0407	.0400
4	.0512	.0505	.0499	.0492	.0485	.0478	.0471	.0464	.0457	.0451	.0444	.0436	.0429	.0422
6	.0539	.0532	.0525	.0518	.0511	.0504	.0497	.0489	.0482	.0475	.0468	.0460	.0452	.0445
8	.0568	.0560	.0553	.0545	.0538	.0530	.0523	.0515	.0508	.0500	.0492	.0484	.0476	.0469
10	0.0597	0.0590	0.0582	0.0574	0.0566	0.0558	0.0550	0.0542	0.0534	0.0526	0.0518	0.0510	0.0502	0.0493
12	.0629	.0620	.0612	.0604	.0596	.0587	.0579	.0570	.0562	.0553	.0545	.0536	.0528	.0519
14	.0660	.0652	.0644	.0635	.0626	.0617	.0609	.0600	.0591	.0582	.0573	.0564	.0555	.0546
16	.0694	.0685	.0676	.0667	.0658	.0646	.0640	.0631	.0621	.0612	.0602	.0593	.0583	.0574
18	.0729	.0719	.0710	.0700	.0691	.0682	.0672	.0662	.0653	.0643	.0633	.0623	.0613	.0603
20	0.0765	0.0755	0.0745	0.0735	0.0726	0.0716	0.0705	0.0695	0.0685	0.0675	0.0665	0.0654	0.0644	0.0633
22	.0803	.0792	.0782	.0772	.0761	.0751	.0740	.0730	.0719	.0709	.0698	.0687	.0676	.0665
24	.0842	.0831	.0820	.0810	.0799	.0787	.0776	.0765	.0754	.0743	.0732	.0720	.0709	.0698
26	.0882	.0871	.0860	.0848	.0837	.0826	.0814	.0803	.0791	.0779	.0767	.0756	.0743	.0732
28	.0924	.0912	.0901	.0889	.0877	.0865	.0853	.0841	.0829	.0817	.0805	.0792	.0779	.0767
30	0.0968	0.0956	0.0943	0.0931	0.0919	0.0907	0.0894	0.0881	0.0869	0.0855	0.0843	0.0830	0.0817	0.0804
32	.101	.100	.0988	.0976	.0962	.0950	.0936	.0923	.0910	.0896	.0883	.0870	.0855	.0842
34	.106	.105	.103	.102	.101	.0993	.0979	.0966	.0952	.0938	.0924	.0910	.0896	.0882
36	.111	.110	.108	.107	.105	.104	.103	.101	.0996	.0982	.0967	.0952	.0938	.0923
38	.116	.115	.113	.112	.110	.109	.107	.106	.104	.103	.101	.0997	.0981	.0965
40	0.121	0.120	0.118	0.117	0.115	0.114	0.112	0.111	0.109	0.107	0.106	0.104	0.103	0.101
42	.127	.125	.124	.122	.120	.119	.117	.115	.114	.112	.111	.109	.107	.106
44	.132	.131	.129	.127	.126	.124	.122	.121	.119	.117	.116	.114	.112	.110
46	.138	.136	.135	.133	.131	.130	.128	.126	.124	.122	.121	.119	.117	.115
48	.144	.142	.141	.139	.137	.135	.133	.132	.130	.128	.126	.124	.122	.120
50	0.150	0.149	0.147	0.145	0.143	0.141	0.139	0.137	0.135	0.133	0.131	0.129	0.128	0.126
52	.157	.155	.153	.151	.149	.147	.145	.143	.141	.139	.137	.135	.133	.131
54	.163	.162	.160	.158	.156	.153	.151	.149	.147	.145	.143	.141	.139	.137
56	.170	.168	.166	.164	.162	.160	.158	.156	.153	.151	.149	.147	.145	.142
58	.178	.175	.173	.171	.169	.167	.164	.162	.160	.158	.155	.153	.151	.148

"Freon-21"—Weight of refrigerant to be circulated
(Saturated vapor leaving evaporator)
Lb per min per ton of refrigerating capacity

Evap Temp	Temperature of liquid ahead of expansion valve													
	60	65	70	75	80	85	90	95	100	105	110	115	120	125
-20	2.15	2.18	2.21	2.24	2.28	2.31	2.34	2.38	2.42	2.46	2.50	2.54	2.58	2.63
-18	2.14	2.18	2.20	2.24	2.27	2.30	2.34	2.37	2.41	2.45	2.49	2.53	2.57	2.62
-16	2.14	2.17	2.20	2.23	2.26	2.30	2.33	2.36	2.40	2.44	2.48	2.52	2.56	2.61
-14	2.13	2.16	2.19	2.22	2.26	2.29	2.32	2.36	2.40	2.43	2.47	2.51	2.56	2.60
-12	2.13	2.16	2.19	2.22	2.25	2.28	2.32	2.35	2.39	2.43	2.46	2.51	2.55	2.59
-10	2.12	2.15	2.18	2.21	2.24	2.28	2.31	2.34	2.38	2.42	2.46	2.50	2.54	2.58
- 8	2.12	2.15	2.18	2.21	2.24	2.27	2.30	2.34	2.37	2.41	2.45	2.49	2.53	2.58
- 6	2.11	2.14	2.17	2.20	2.23	2.26	2.30	2.33	2.37	2.40	2.44	2.48	2.53	2.57
- 4	2.11	2.14	2.16	2.20	2.23	2.26	2.29	2.33	2.36	2.40	2.44	2.48	2.52	2.56
- 2	2.10	2.13	2.16	2.19	2.22	2.25	2.28	2.32	2.35	2.39	2.43	2.47	2.51	2.55
0	2.10	2.12	2.15	2.18	2.21	2.24	2.28	2.31	2.35	2.38	2.42	2.46	2.50	2.55
2	2.09	2.12	2.15	2.18	2.21	2.24	2.27	2.31	2.34	2.38	2.42	2.45	2.50	2.54
4	2.09	2.11	2.14	2.17	2.20	2.23	2.27	2.30	2.34	2.37	2.41	2.45	2.49	2.53
6	2.08	2.11	2.14	2.17	2.20	2.23	2.26	2.29	2.33	2.36	2.40	2.44	2.48	2.52
8	2.08	2.10	2.13	2.16	2.19	2.22	2.25	2.29	2.32	2.36	2.39	2.43	2.47	2.52
10	2.07	2.10	2.13	2.16	2.18	2.22	2.25	2.28	2.32	2.35	2.39	2.43	2.47	2.51
12	2.06	2.09	2.12	2.15	2.18	2.21	2.24	2.28	2.31	2.34	2.38	2.42	2.46	2.50
14	2.06	2.09	2.12	2.14	2.17	2.20	2.24	2.27	2.30	2.34	2.37	2.41	2.45	2.49
16	2.06	2.08	2.11	2.14	2.17	2.20	2.23	2.26	2.30	2.33	2.37	2.40	2.44	2.48
18	2.05	2.08	2.10	2.13	2.16	2.19	2.22	2.26	2.29	2.32	2.36	2.40	2.44	2.48
20	2.04	2.07	2.10	2.13	2.16	2.19	2.22	2.25	2.28	2.32	2.35	2.39	2.43	2.47
22	2.04	2.07	2.09	2.12	2.15	2.18	2.21	2.24	2.28	2.31	2.35	2.38	2.42	2.46
24	2.04	2.06	2.09	2.12	2.14	2.18	2.21	2.24	2.27	2.30	2.34	2.38	2.42	2.46
26	2.03	2.06	2.08	2.11	2.14	2.17	2.20	2.23	2.26	2.30	2.33	2.37	2.41	2.45
28	2.02	2.05	2.08	2.11	2.13	2.16	2.19	2.23	2.26	2.29	2.33	2.36	2.40	2.44
30	2.02	2.05	2.07	2.10	2.13	2.16	2.19	2.22	2.25	2.29	2.32	2.36	2.40	2.43
32	2.02	2.04	2.07	2.10	2.12	2.15	2.18	2.21	2.25	2.28	2.31	2.35	2.39	2.43
34	2.01	2.04	2.06	2.09	2.12	2.15	2.18	2.21	2.24	2.27	2.31	2.34	2.38	2.42
36	2.00	2.03	2.06	2.08	2.11	2.14	2.17	2.20	2.23	2.27	2.30	2.34	2.37	2.41
38	2.00	2.03	2.05	2.08	2.11	2.14	2.16	2.20	2.23	2.26	2.30	2.33	2.37	2.40
40	2.00	2.02	2.05	2.07	2.10	2.13	2.16	2.19	2.22	2.26	2.29	2.32	2.36	2.40
42	1.99	2.02	2.04	2.07	2.10	2.12	2.15	2.18	2.22	2.25	2.28	2.32	2.35	2.39
44	1.99	2.01	2.04	2.06	2.09	2.12	2.15	2.18	2.21	2.24	2.28	2.31	2.35	2.38
46	1.98	2.01	2.03	2.06	2.09	2.11	2.14	2.17	2.20	2.24	2.27	2.30	2.34	2.38
48	1.98	2.00	2.03	2.05	2.08	2.11	2.14	2.17	2.20	2.23	2.26	2.30	2.33	2.37
50	1.97	2.00	2.02	2.05	2.08	2.10	2.13	2.16	2.19	2.22	2.26	2.29	2.33	2.36
52	1.97	1.99	2.02	2.04	2.07	2.10	2.13	2.16	2.19	2.22	2.25	2.28	2.32	2.36
54	1.96	1.99	2.01	2.04	2.06	2.09	2.12	2.15	2.18	2.21	2.24	2.28	2.32	2.35
56	1.96	1.98	2.01	2.03	2.06	2.09	2.12	2.14	2.18	2.21	2.24	2.27	2.31	2.34
58	1.95	1.98	2.00	2.03	2.06	2.08	2.11	2.14	2.17	2.20	2.23	2.27	2.30	2.34

"Freon-21"—Theoretical horsepower per cu ft per min of vapor compressed

Evap Temp	Condensing temperature													
	60	65	70	75	80	85	90	95	100	105	110	115	120	125
-20	0.0260	0.0275	0.0289	0.0304	0.0320	0.0334	0.0348	0.0362	0.0376	0.0390	0.0403	0.0417	0.0431	0.0444
-18	.0266	.0279	.0298	.0313	.0329	.0344	.0359	.0374	.0389	.0403	.0417	.0432	.0446	.0460
-16	.0273	.0289	.0306	.0322	.0338	.0354	.0370	.0386	.0402	.0417	.0432	.0447	.0462	.0476
-14	.0279	.0296	.0313	.0331	.0348	.0364	.0382	.0398	.0414	.0430	.0446	.0462	.0478	.0492
-12	.0285	.0303	.0321	.0339	.0357	.0374	.0393	.0410	.0427	.0444	.0460	.0477	.0494	.0509
-10	0.0290	0.0309	0.0328	0.0347	0.0366	0.0384	0.0403	0.0421	0.0440	0.0457	0.0474	0.0492	0.0510	0.0526
- 8	.0295	.0315	.0335	.0355	.0375	.0394	.0414	.0433	.0452	.0470	.0488	.0507	.0526	.0543
- 6	.0301	.0322	.0343	.0363	.0385	.0405	.0425	.0446	.0466	.0485	.0504	.0523	.0543	.0561
- 4	.0306	.0328	.0351	.0372	.0394	.0415	.0437	.0458	.0479	.0499	.0519	.0539	.0560	.0579
- 2	.0310	.0333	.0356	.0379	.0402	.0425	.0447	.0469	.0491	.0512	.0533	.0554	.0576	.0596
0	0.0314	0.0338	0.0363	0.0386	0.0410	0.0434	0.0458	0.0481	0.0504	0.0526	0.0548	0.0571	0.0593	0.0614
2	.0317	.0343	.0369	.0394	.0418	.0443	.0468	.0492	.0517	.0540	.0563	.0587	.0610	.0632
4	.0320	.0347	.0374	.0400	.0426	.0452	.0479	.0503	.0529	.0554	.0578	.0603	.0627	.0650
6	.0323	.0351	.0379	.0407	.0433	.0461	.0488	.0515	.0542	.0567	.0593	.0618	.0644	.0668
8	.0324	.0354	.0384	.0412	.0440	.0469	.0497	.0525	.0553	.0580	.0607	.0634	.0660	.0685
10	0.0325	0.0356	0.0387	0.0417	0.0447	0.0477	0.0506	0.0535	0.0565	0.0593	0.0621	0.0649	0.0677	0.0702
12	.0327	.0360	.0392	.0424	.0455	.0486	.0516	.0547	.0578	.0607	.0636	.0666	.0695	.0722
14	.0326	.0361	.0394	.0427	.0460	.0492	.0524	.0556	.0588	.0619	.0649	.0680	.0710	.0739
16	.0324	.0361	.0395	.0429	.0463	.0497	.0530	.0564	.0597	.0629	.0661	.0693	.0725	.0755
18	.0324	.0362	.0398	.0433	.0469	.0504	.0539	.0574	.0608	.0642	.0675	.0709	.0742	.0774
20	0.0322	0.0362	0.0399	0.0436	0.0474	0.0511	0.0547	0.0583	0.0619	0.0654	0.0689	0.0724	0.0759	0.0792
22	.0320	.0361	.0400	.0438	.0477	.0516	.0554	.0592	.0629	.0666	.0703	.0739	.0775	.0810
24	.0314	.0356	.0397	.0437	.0478	.0518	.0558	.0597	.0636	.0675	.0713	.0751	.0788	.0825
26	.0308	.0353	.0396	.0438	.0480	.0522	.0563	.0604	.0645	.0685	.0725	.0764	.0803	.0842
28	.0302	.0348	.0393	.0437	.0481	.0525	.0568	.0610	.0653	.0694	.0736	.0777	.0817	.0858
30	0.0295	0.0342	0.0389	0.0435	0.0480	0.0527	0.0572	0.0616	0.0660	0.0703	0.0747	0.0789	0.0831	0.0873
32	.0286	.0335	.0384	.0433	.0479	.0528	.0574	.0620	.0666	.0711	.0757	.0801	.0845	.0888
34	.0275	.0327	.0378	.0429	.0477	.0528	.0575	.0623	.0672	.0718	.0766	.0812	.0857	.0902
36	.0262	.0317	.0370	.0423	.0473	.0526	.0575	.0625	.0676	.0724	.0773	.0822	.0868	.0915
38	.0252	.0308	.0364	.0418	.0472	.0526	.0577	.0629	.0682	.0732	.0783	.0833	.0883	.0930
40	0.0237	0.0295	0.0353	0.0410	0.0465	0.0522	0.0575	0.0629	0.0683	0.0736	0.0789	0.0842	0.0892	0.0942
42	.0223	.0284	.0344	.0403	.0461	.0519	.0575	.0631	.0688	.0742	.0797	.0851	.0905	.0956
44	.0205	.0268	.0330	.0391	.0452	.0512	.0570	.0629	.0687	.0743	.0801	.0858	.0913	.0967
46	.0187	.0253	.0318	.0381	.0444	.0507	.0568	.0628	.0689	.0747	.0807	.0866	.0924	.0979
48	.0165	.0233	.0301	.0365	.0432	.0496	.0560	.0622	.0685	.0747	.0808	.0870	.0929	.0987
50	0.0143	0.0214	0.0285	0.0351	0.0421	0.0487	0.0554	0.0619	0.0684	0.0748	0.0812	0.0876	0.0937	0.0997
52	.0120	.0194	.0267	.0336	.0409	.0478	.0547	.0615	.0681	.0747	.0814	.0880	.0944	.101
54	.00901	.0167	.0243	.0315	.0390	.0461	.0534	.0604	.0673	.0742	.0811	.0879	.0945	.101
56	.00622	.0143	.0221	.0296	.0374	.0448	.0522	.0596	.0666	.0738	.0810	.0880	.0949	.102
58		.0115	.0196	.0274	.0354	.0431	.0508	.0584	.0658	.0733	.0806	.0880	.0951	.102

"Freon-21"—Theoretical horsepower of refrigerating compressors

(Saturated vapor entering compressor)

Horsepower per ton

Evap Temp	Condensing temperature													
	60	65	70	75	80	85	90	95	100	105	110	115	120	125
-20	0.987	1.06	1.13	1.20	1.28	1.36	1.44	1.52	1.61	1.69	1.78	1.87	1.96	2.06
-18	.954	1.02	1.10	1.17	1.24	1.32	1.40	1.48	1.56	1.65	1.73	1.82	1.92	2.01
-16	.922	0.991	1.06	1.13	1.21	1.28	1.36	1.44	1.52	1.61	1.69	1.78	1.87	1.96
-14	.890	0.958	1.03	1.10	1.17	1.25	1.33	1.40	1.48	1.56	1.65	1.74	1.83	1.92
-12	.859	0.926	0.994	1.06	1.14	1.21	1.29	1.36	1.44	1.52	1.61	1.69	1.78	1.87
-10	0.827	0.893	0.962	1.03	1.10	1.17	1.25	1.33	1.41	1.48	1.56	1.65	1.74	1.83
- 8	.796	.861	.928	0.996	1.07	1.14	1.21	1.29	1.37	1.44	1.52	1.61	1.70	1.78
- 6	.767	.832	.899	0.966	1.04	1.11	1.18	1.26	1.33	1.41	1.49	1.57	1.66	1.74
- 4	.739	.804	.870	0.936	1.00	1.08	1.15	1.22	1.30	1.37	1.45	1.53	1.62	1.70
- 2	.708	.772	.838	0.903	0.970	1.04	1.11	1.18	1.26	1.33	1.41	1.49	1.57	1.66
0	0.681	0.744	0.808	0.873	0.939	1.01	1.08	1.15	1.22	1.30	1.37	1.45	1.54	1.62
2	.653	.716	.780	.844	.909	0.976	1.05	1.12	1.19	1.26	1.34	1.42	1.50	1.58
4	.625	.688	.751	.814	.879	0.945	1.02	1.08	1.16	1.23	1.30	1.38	1.46	1.54
6	.598	.660	.722	.785	.848	0.914	0.983	1.05	1.12	1.19	1.27	1.34	1.42	1.50
8	.571	.632	.694	.756	.819	0.884	0.952	1.02	1.09	1.16	1.23	1.31	1.39	1.46
10	0.544	0.604	0.666	0.727	0.789	0.854	0.920	0.987	1.06	1.13	1.20	1.27	1.35	1.42
12	.520	.580	.641	.701	.763	.827	.892	.958	1.03	1.10	1.17	1.24	1.32	1.39
14	.494	.553	.613	.673	.734	.797	.861	.927	0.995	1.06	1.13	1.21	1.28	1.35
16	.467	.526	.585	.644	.705	.767	.829	.895	0.961	1.03	1.10	1.17	1.24	1.32
18	.444	.503	.560	.618	.678	.740	.802	.866	0.932	0.999	1.07	1.14	1.21	1.28
20	0.421	0.479	0.536	0.593	0.652	0.714	0.775	0.838	0.903	0.969	1.04	1.11	1.18	1.25
22	.398	.455	.512	.568	.627	.687	.749	.811	.875	.940	1.01	1.08	1.15	1.22
24	.373	.429	.484	.540	.598	.658	.718	.780	.844	.908	0.974	1.04	1.11	1.18
26	.349	.405	.460	.516	.573	.632	.692	.753	.815	.879	0.944	1.01	1.08	1.15
28	.327	.382	.436	.492	.548	.607	.665	.726	.788	.850	0.915	0.981	1.05	1.12
30	0.304	0.358	0.412	0.468	0.523	0.582	0.639	0.699	0.760	0.822	0.886	0.951	1.02	1.09
32	.282	.335	.389	.444	.498	.556	.613	.672	.733	.794	.857	.922	0.987	1.05
34	.259	.312	.365	.420	.474	.532	.587	.645	.705	.766	.828	.892	0.957	1.02
36	.236	.289	.342	.396	.449	.506	.561	.619	.678	.738	.799	.863	0.926	0.991
38	.217	.269	.321	.375	.428	.484	.538	.595	.654	.713	.774	.836	0.900	0.964
40	0.195	0.246	0.299	0.351	0.404	0.459	0.513	0.569	0.627	0.686	0.746	0.808	0.870	0.933
42	.176	.227	.278	.330	.383	.438	.491	.547	.604	.661	.721	.782	.844	.906
44	.155	.205	.256	.307	.360	.413	.466	.521	.578	.634	.694	.754	.815	.877
46	.136	.186	.236	.286	.338	.391	.444	.498	.554	.610	.669	.729	.790	.850
48	.114	.163	.214	.263	.315	.367	.420	.473	.528	.584	.642	.701	.760	.820
50	0.0953	0.144	0.194	0.243	0.295	0.345	0.398	0.451	0.505	0.560	0.617	0.676	0.735	0.794
52	.0766	.125	.175	.223	.274	.325	.377	.429	.482	.537	.594	.651	.709	.769
54	.0551	.103	.152	.200	.251	.301	.353	.405	.457	.511	.567	.623	.681	.739
56	.0365	.0846	.133	.180	.231	.280	.331	.383	.434	.488	.543	.599	.656	.714
58		.0653	.113	.160	.210	.259	.309	.360	.411	.465	.519	.575	.631	.688

"Freon-21"—Volume of refrigerant to be compressed

(Saturated vapor leaving evaporator)

Cu ft per min per ton of refrigerating capacity

Evap Temp	Temperature of liquid ahead of expansion valve													
	60	65	70	75	80	85	90	95	100	105	110	115	120	125
-20	38.0	38.5	39.0	39.6	40.2	40.8	41.4	42.0	42.7	43.4	44.1	44.8	45.6	46.4
-18	35.8	36.3	36.8	37.3	37.9	38.4	39.0	39.6	40.2	40.9	41.5	42.2	43.0	43.7
-16	33.8	34.3	34.7	35.2	35.7	36.3	36.8	37.4	38.0	38.6	39.2	39.8	40.5	41.2
-14	31.9	32.4	32.8	33.3	33.8	34.2	34.8	35.3	35.8	36.4	37.0	37.6	38.2	38.9
-12	30.2	30.6	31.0	31.4	31.9	32.3	32.8	33.3	33.8	34.4	34.9	35.5	36.1	36.7
-10	28.5	28.9	29.3	29.7	30.1	30.6	31.0	31.5	32.0	32.5	33.0	33.6	34.1	34.7
- 8	27.0	27.3	27.7	28.1	28.5	28.9	29.3	29.8	30.2	30.7	31.2	31.7	32.2	32.8
- 6	25.5	25.9	26.2	26.6	27.0	27.4	27.8	28.2	28.6	29.0	29.5	30.0	30.5	31.0
- 4	24.2	24.5	24.8	25.2	25.5	25.9	26.3	26.7	27.1	27.5	27.9	28.4	28.9	29.4
- 2	22.9	23.2	23.5	23.8	24.2	24.5	24.9	25.2	25.6	26.0	26.4	26.9	27.3	27.8
0	21.7	22.0	22.3	22.6	22.9	23.2	23.6	23.9	24.3	24.7	25.1	25.5	25.9	26.4
2	20.6	20.8	21.1	21.4	21.7	22.0	22.4	22.7	23.0	23.4	23.8	24.2	24.6	25.0
4	19.5	19.8	20.0	20.3	20.6	20.9	21.2	21.5	21.9	22.2	22.5	22.9	23.3	23.7
6	18.5	18.8	19.0	19.3	19.6	19.8	20.1	20.4	20.7	21.1	21.4	21.7	22.1	22.5
8	17.6	17.8	18.1	18.3	18.6	18.8	19.1	19.4	19.7	20.0	20.3	20.6	21.0	21.3
10	16.7	17.0	17.2	17.4	17.7	17.9	18.2	18.4	18.7	19.0	19.3	19.6	19.9	20.3
12	15.9	16.1	16.3	16.6	16.8	17.0	17.3	17.5	17.8	18.1	18.3	18.6	19.0	19.3
14	15.1	15.3	15.5	15.8	16.0	16.2	16.4	16.7	16.9	17.2	17.4	17.7	18.0	18.3
16	14.4	14.6	14.8	15.0	15.2	15.5	15.6	15.9	16.1	16.3	16.6	16.9	17.1	17.4
18	13.7	13.9	14.1	14.3	14.5	14.7	14.9	15.1	15.3	15.6	15.8	16.0	16.3	16.6
20	13.1	13.2	13.4	13.6	13.8	14.0	14.2	14.4	14.6	14.8	15.0	15.3	15.5	15.8
22	12.5	12.6	12.8	13.0	13.1	13.3	13.5	13.7	13.9	14.1	14.3	14.6	14.8	15.0
24	11.9	12.0	12.2	12.4	12.5	12.7	12.9	13.1	13.3	13.5	13.7	13.9	14.1	14.3
26	11.3	11.5	11.6	11.8	12.0	12.1	12.3	12.5	12.6	12.8	13.0	13.2	13.4	13.7
28	10.8	11.0	11.1	11.2	11.4	11.6	11.7	11.9	12.1	12.2	12.4	12.6	12.8	13.0
30	10.3	10.5	10.6	10.7	10.9	11.0	11.2	11.4	11.5	11.7	11.9	12.0	12.2	12.4
32	9.86	9.99	10.1	10.2	10.4	10.5	10.7	10.8	11.0	11.2	11.3	11.5	11.7	11.9
34	9.42	9.54	9.67	9.80	9.93	10.1	10.2	10.4	10.5	10.7	10.8	11.0	11.2	11.3
36	9.01	9.12	9.24	9.36	9.49	9.62	9.75	9.89	10.0	10.2	10.3	10.5	10.7	10.8
38	8.62	8.72	8.84	8.95	9.07	9.20	9.32	9.46	9.59	9.74	9.88	10.0	10.2	10.4
40	8.24	8.35	8.45	8.57	8.68	8.80	8.92	9.05	9.18	9.31	9.45	9.60	9.75	9.90
42	7.89	7.99	8.09	8.20	8.31	8.42	8.54	8.66	8.78	8.91	9.04	9.18	9.33	9.48
44	7.56	7.65	7.75	7.85	7.95	8.06	8.18	8.29	8.41	8.53	8.66	8.79	8.93	9.07
46	7.24	7.33	7.42	7.52	7.62	7.72	7.82	7.93	8.05	8.17	8.29	8.41	8.55	8.68
48	6.93	7.02	7.11	7.20	7.30	7.40	7.50	7.60	7.71	7.82	7.94	8.06	8.18	8.32
50	6.65	6.73	6.81	6.90	7.00	7.09	7.18	7.29	7.39	7.50	7.61	7.72	7.84	7.97
52	6.37	6.45	6.53	6.62	6.70	6.80	6.89	6.99	7.08	7.19	7.29	7.40	7.52	7.64
54	6.14	6.19	6.26	6.35	6.43	6.52	6.60	6.70	6.79	6.89	6.99	7.10	7.21	7.32
56	5.87	5.94	6.01	6.09	6.17	6.25	6.34	6.42	6.52	6.61	6.71	6.81	6.91	7.02
58	5.63	5.70	5.77	5.84	5.92	6.00	6.08	6.16	6.25	6.34	6.43	6.53	6.63	6.74

SAM LEWIS' PAGE

IN THIS regular feature, informal comment on heating, piping, and air conditioning matters is given by Samuel R. Lewis, consulting mechanical engineer, member of our board of consulting and contributing editors

Answers Reader's Question on Sizing Piping for Unit Heaters

E. C. K. HAS asked (see his questions herewith) how to determine pipe sizes for return of condensate to a pump, the latter not being arranged to promote subatmospheric pressure. Evidently he is thinking about the condensate drainage from a unit heater.

Answering his question about where to find definite information on pipe sizing, especially return pipe sizes when a condensation pump is used, ASHVE's Heating, Ventilating, Air Conditioning Guide has an excellent chapter on steam heating systems and piping, based on exhaustive research. Tables 4 and 5 of this chapter tell the story. Thus, if a unit heater has an output equivalent to 400 sq ft of steam radiation and is above the receiver of the pump and is not over 100 equivalent linear feet distant, inspection of the table indicates that a 1½ in. steam supply would serve (good for 538 EDR at ½ lb pressure drop) and that the condensate would be cared for by a ¾ in. pipe if 1/16 lb difference in pressure between that at the heater outlet and that in the receiver is maintained.

Install Trap at Each Outlet

It is customary and wise in designing pipe systems for unit heaters to install a trap at the outlet of each one, just as though a vacuum pump were to be installed. It is possible to substitute a swing check valve for the trap, but this is much less satisfactory. Unless some device of this sort is present, however, steam enters the return mains through the heaters that have the least work to do and may interfere with orderly drainage of the heaters that have the most work to do. There must be provision at the receiver of the vacuum pump to permit free escape of air. The capacity of the piping depends on the difference in pressure between the inlet and the outlet.

In answer to E.C.K.'s second question about the pressure drop to use when the unit heaters are selected on the basis of 2 lb and 5 lb steam pressure, I would use the same pressure drop for either 2 lb steam or 5 lb steam or for atmospheric steam pressure. The pressure drop is an exponent of differential or friction and the pipe size is governed within practical steamfitting limits by this difference.

E.C.K. also asks if any reduction in return pipe sizes can be made because a condensation return pump is used.

Apparently the answer sought by this question is whether the size of an untrapped return that runs directly to the boiler from the unit heater can be reduced if its principal differential is the distance that the bottom of the unit heater is above the water level in the boiler. This answer is *no*.

Referring to Table 5 in the Guide, a 1 in. return main assuredly above the boiler water level would be capable of serving 248 equivalent sq ft with 1/32 lb pressure drop per 100 ft of run. If this pressure drop, by means of the receiver of the condensate pump being several feet lower than the water level in the boiler, is increased to ¼ lb, the 1 in. return would serve 460 EDR.

On the discharge of the condensate pump the pipe connecting to the boiler can, of course, be reduced, this being an exponent of the pump capacity and motive power.

If a pump must be used, I would choose a vacuum pump, as it permits smaller pipe sizes and militates in favor of reduced pipe corrosion by assured removal of excess air.

Asks About Pipe Sizes on Unit Heater Jobs

"I would appreciate receiving some information on piping for steam unit heaters when a condensation return pump is used. My questions are as follows:

"Where can I find definite information on pipe sizing, especially return pipe sizes, when a condensation return pump is used?

"What pressure drop should be used when the unit heaters are selected on the basis of 2 lb steam pressure, and on the basis of 5 lb steam pressure?

"Can any reduction in return pipe sizes be made because a condensation return pump is used?"

—E.C.K.

NEW BOOKS & REPORTS

Pressure Welding of Overland Pipe Lines

The pressure welding process has been successfully applied on over 1500 miles of overland piping for oil, natural gas, water, helium, and propane. In a paper, The Application of Pressure Welding to Overland Pipe Lines, which was scheduled for presentation at the 26th annual meeting of the American Welding Society, E. P. Jones describes the welding procedure and the equipment used.

The welding machine, which is semi-automatic, is suspended from the side boom of a standard pipe line track-type tractor on the end of a steel cable. Hydraulically controlled gripping dogs are used to provide proper alignment, and end pressure to produce upsetting during welding is provided by hydraulic cylinders at the ends of two pull rods which run the length of the machine. Special oxyacetylene heating heads were developed with small diameter flame ports being closely spaced so that heat distribution at the weld joint approached a continuous ribbon of flame.

According to the author, all grades and compositions of line pipe can be readily pressure welded. These are, in general, steels containing carbon and manganese as the principal alloying elements. In addition, properly made field pressure welds will pass the usual tensile, free bend, and root bend tests. The most outstanding feature of this method is said to be the production of a large number of field welds in which the quality is uniform.

Selection of Vibration Isolating Materials for Refrigeration Equipment

In recent years the refrigeration industry has been faced with the problem of designing isolation mountings for rotative equipment so as to diminish the amount of transmitted vibrational energy. Because of differences in the nature of various parts which are to be isolated, some require a low natural frequency which can be obtained only in spring mountings, some require rubber isolators, and for others cork or felt is suitable. In selecting suitable isolating materials the major problem consists of determining the transmissibility for the various materials under consideration.

The results of a number of tests on various kinds of isolation cork and felt, as well as several types of standard rubber isolators, are contained in a paper, Evaluation of Vibration Isolation Materials for Refrigeration Equipment, by E. S. Bishop and J. A. Galazzi, of the York Corp., which was prepared for presentation at the 41st annual meeting of the American Society of Refrigerating Engineers.

The authors have concluded that there is general misuse of the basic equation for determining the isolation properties of various materials from the static deflection of the material under load. For such materials as felt, cork, and rubber the misuse of the basic natural frequency equation can lead to serious error resulting in actually amplifying the vibration. For example, the instantaneous static deflection of a 2 in. thick sample of cork was found to be approximately 0.2 in. with a 37.5 lb per sq in. loading. Using the basic equation for natural frequency $f_n = 188\sqrt{\frac{1}{\text{deflection}}}$, one would expect the natural frequency to be 419 rpm, whereas it was actually found to be 685 rpm. To present test information whereby actual natural frequencies can be obtained, the authors determined the critical frequencies, by test, for various materials under different loads. By substitution in the foregoing equation, a "dynamic deflection" is obtained. This value is used in the following equation:

$$d = \frac{Pt}{EA}$$

where d = deflection, in.
P = loading, lb
t = thickness, in.
E = modulus of elasticity, lb per sq in.
A = area, sq in.

A dynamic modulus is thus found which, when plotted against loadings for various materials, provides a means for determining natural frequencies. For materials having a tendency to drift, such as cork and felt, this modulus is said to be about the only means for expressing the relationship between loading and natural frequency. This modulus was also found to increase with the thickness of isolation material.

Also mentioned in this paper is the necessity for guarding against rocking frequencies about the three primary axes. It is recommended that as large an inertia mass as possible be used around those axes having the largest pulsating torques.

ASME Heat Transfer Papers

The November 1945 issue of the Transactions of the American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y., contains the following papers which were contributed by the heat transfer division and presented at the 1944 annual meeting of the ASME in New York City:

Heat Transfer from a Baffled-Finned Cylinder to Air, by A. W. Lemmon, Jr., A. P. Colburn, and H. B. Nottage; Local Coefficients of Heat Transfer for Air Flowing Around a Finned Cylinder, by W. H. McAdams, R. E. Drexel, and R. H. Goldey; Efficiency of Extended Surface, by K. A. Gardner; Tube Spacing in Finned-Tube Banks, by S. L. Jameson; A General Correlation of Friction Factors for Various Types of Surfaces in Crossflow, by A. Y. Gunter and W. A. Shaw; Air-Cooled Steam Condensers, by R. A. Bowman; Heat Transfer Through Tubes with Integral Spiral Fins, by D. L. Katz, K. O. Beatty, Jr., and A. S. Foust; Heat Transfer and Pressure Loss in Small Commercial Shell-and-Finned-Tube Heat Exchangers, by R. M. Armstrong; Heat-Transfer Coefficients and Other Data on Individual Serrated-Finned Surface, by E. A. Schryber; Disk Extended Surfaces for High Heat-Absorption Rates, by G. E. Tate and John Cartinbour; Heat-Flux Pattern in Fin Tubes Under Radiation, by B. De Lorenzo and E. D. Anderson; Numerical Methods for Transient Heat Flow, by G. M. Dusinberre; An Electrical Geometrical Analogue for Complex Heat Flow, by C. F. Kayan.

Thermal Conductivity of Insulating Materials at Low Mean Temperatures

A paper on thermal conductivity of Insulating Materials at Low Mean Temperatures, prepared by F. B. Rowley, R. C. Jordan and R. M. Lander, was presented at the 41st annual meeting of the American Society of Refrigerating Engineers in New York City.

Reasonably complete data concerning the thermal conductivities of insulating materials at mean temperatures of 70 to 90 F have been obtained as the result of research sponsored by or conducted in cooperation with the heating and ventilating industry. Incomplete test values for temperatures of 30 to 40 F have also been published. To provide more complete and practical information as to the variations of thermal conductivity with variations in mean temperatures, a research project has been conducted at the University of Minnesota Engineering Experiment Station using common insulating materials which were tested at mean temperatures ranging from —60 to 90 F.

A modified form of the standard guarded hot plate was used for the determination of thermal conductivities and cold plate temperatures of as low as —70 F were obtained by circulating alcohol cooled with a single stage "Freon 22" compressor. A vapor sealed and insulated enclosure was constructed around the hot plate. Tests were conducted to determine the variation in thermal conductivity of corkboard, wood fiber board, mineral wool board, cellular glass block, glass wool, rock wool, redwood bark, and silica aerogel at mean temperatures varying between —60 F and 90 F.

An inspection of the charts and tabulated data which show the test results indicates that the thermal conductivities of these materials decrease approximately 15 to 40 per cent with a mean temperature decrease of 150 F. It is interesting to note that for the rigid insulating materials such as corkboard, wood fiber board, mineral wool board, and cellular glass block the temperature conductivity curves are linear. In the cases of the loosely packed materials such as silica aerogel, rock wool, glass wool, and redwood bark, the graphs show a positive curvature. In addition, the loosely packed materials undergo a greater percentage change. It is probable that more radiant heat transfer takes place in the loosely packed materials.

As stated by the authors, these observations in regard to thermal conductivities, temperatures, and densities are only approximate, as density is only one of the controlling factors. In addition, these data were obtained under laboratory conditions, whereas field applications may be complicated by such factors as moisture condensation. More extensive tests including additional materials are to be conducted in the future.

Fans and Blowers

Standards, Definitions, and Terms in Use by the Blower Industry will prove to be helpful to those persons who hope to find, in a brief pamphlet, an explanation of the more common terms used in connection with fans and blowers for heating, ventilating, air conditioning, and air handling. General types and classes of fans are defined and the standard designations for arrangements of drive, rotation, motor position for belt or chain drive, discharge, and inlet boxes are given. Air density ratios at various altitudes and air temperatures together with the standards for maximum outlet areas for 25 sizes of wheel diameters are included. Brief mention is made of fan performance curves, standard air and flue gas densities, abrasion, and field testing of fans.

Copies of this 11 page bulletin (No. 105) may be obtained at no charge from the National Association of Fan Manufacturers, 5-208 General Motors Bldg., Detroit, Mich.

Stoker Manufacturers Information Manual

The Stoker Manufacturers Association has issued a third edition of its Information Manual which comprises listings of stoker manufacturer members and associate members of the SMA.

All changes and additions in personnel, addresses, and names have been brought up to date. Other helpful information is included, especially for the reference and use of members of the association and others in allied industries who are interested in stokers and the listed manufacturers and supplying firms.

Copies of the manual may be secured (for 50c each) from the association headquarters, 307 N. Michigan Ave., Chicago 1, Ill.

Opportunities in the Construction Industry

Most estimates of the construction industries' needs indicate that 200,000 more skilled men will be needed to meet the expected postwar volume of construction. With millions of men returning from the service, this would not appear to be an exorbitant figure, but the end of the war has not provided any quick, easy solution to the manpower problem. Employment ceilings are off, the serviceman is looking for a job, but he doesn't want just any job, he wants a job with a future, and, if necessary, he is willing to train for it.

The Committee on Opportunities for Veterans in the Construction Industry has recognized the need of adequate information and has prepared a timely booklet designed to attract capable men to the industry. Although it is directed primarily to the veteran, it contains valuable information for others, including the employer himself.

This booklet summarizes the many opportunities, duties, and requirements for various types of work in the construction industry. It tells how to take advantage of these opportunities—how to select the trade, profession, or business for which one is best suited.

It is divided into seven parts, each part dealing with the various fields of construction—what training is needed, how army and previous civilian training can be utilized, what financial aid can be secured for apprenticeship training or education under the GI Bill of Rights, how to select a good school, what wages to expect, etc. It tells where to secure further and more detailed information and will thus save much time and effort.

This booklet, which was prepared with the aid of such organizations as the American Institute of Architects, American Society of Civil Engineers, American Society of Mechanical Engineers, Swarthmore College, United States Employment Service, Veterans' Employment Service, and many others, can be secured from E. Lawrence Chandler, Room 703, 1026-17th St., N. W., Washington 6, D. C., at a cost of 10 cents.

MEETINGS & CONVENTIONS

National Plastics Exposition, April 22-27

The Society of the Plastics Industry, 295 Madison Ave., New York 17, N. Y., has announced the first national plastics exposition which is to be held at Grand Central Palace, New York City, April 22-27, 1946.

The exposition is designed to aid the manufacturer in determining uses of plastics in his own line and to bring to his attention the latest methods, machinery, and services in the field of plastics.

Concurrently with the exposition, the Society of the Plastics Industry will hold a convention at which the latest advances in plastics technology and application will be discussed by authorities in the field.

The exposition will be open to the general public during the last three days.

National Oil Heat Exposition

The National Oil Heat Exposition, under the sponsorship of the Oil Heat Institute of America, 30 Rockefeller Plaza, New York 20, N.Y., will be held in Philadelphia, April 23 to 27, at the Commercial Museum, which provides the largest exhibition floor in the history of the exposition.

"The exposition, and concurrent OHI convention, come at a very strategic time," said C. F. Curtin, exposition manager.

The OHI is unable to reserve the large number of rooms in the headquarters hotel that has been customary in other years. It is therefore urged that those planning to attend forward their hotel requirements (including first, second, and third choice hotels) to Charles L. Todd, convention manager, Philadelphia Convention and Visitors Bureau, 1127 Walnut St., Philadelphia 7, Pa.

Corrosion Engineers to Meet May 7-9

National Association of Corrosion Engineers, annual meeting, May 7-9, President hotel, Kansas City. Association headquarters, Southern Standards Bldg., 711 Main St., Houston 2, Tex.

Marine Exposition May 20-25

National Marine Exposition; May 20-25, Grand Central Palace, New York City. Headquarters, National Marine Expositions, Inc., 17 Battery Pl., New York City.

HPACCNA 57th Annual Convention To Be Held in Atlantic City

The members of the Heating, Piping, and Air Conditioning Contractors National Association will meet in their 57th annual convention at the Ritz-Carlton hotel, Atlantic City, N.J., May 22 to 25.

Plans now call for a five session convention beginning the afternoon of Wednesday the 22nd. The complete program and details concerning entertainment will be announced by the convention committee at a later date. The association headquarters is at 1250 Sixth Ave., New York 20, N.Y.

NDHA Annual Meeting June 3-6

National District Heating Association, annual meeting, June 3-6, The Cavalier, Virginia Beach, Va. Association headquarters, 827 N. Euclid Ave., Pittsburgh 6, Pa.

Stoker Manufacturers Meeting

The Stoker Manufacturers Association, 307 N. Michigan Ave., Chicago 1, Ill., has announced that the 1946 annual meeting will be held at the Broadmoor Hotel, Colorado Springs, Colo., on June 3 and 4.

Because of the limited hotel accommodations, it has been decided, according to a special letter issued recently, that all reservations will be handled through the association and that attendance will be restricted to members, associate members, and guests representing the press, national coal organizations, research organizations, and allied industry organizations such as boiler, furnace and accessory national institutes and associations.

ASRE 32nd Spring Meeting

According to a recent announcement, it is expected that the use of the St. Paul Hotel, St. Paul, Minn., will be obtained for the 32nd spring meeting of the American Society of Refrigerating Engineers, 40 W. 40th St., New York 18, N. Y.

The Twin City Section of the ASRE, only two years old, will be host to the society on this occasion, which is scheduled for June 3-5.

ASME Meetings

The American Society of Mechanical Engineers, 29 W. 39th St., New York, N. Y., has announced that its semi-annual meeting will be held in Detroit, Mich., June 12 to 15, 1946. September 30 to October 2 has been set for its fall meeting in Boston, Mass., and the annual meeting is to be held December 2 to 6 in New York City.

ASHVE Semi-Annual Meeting

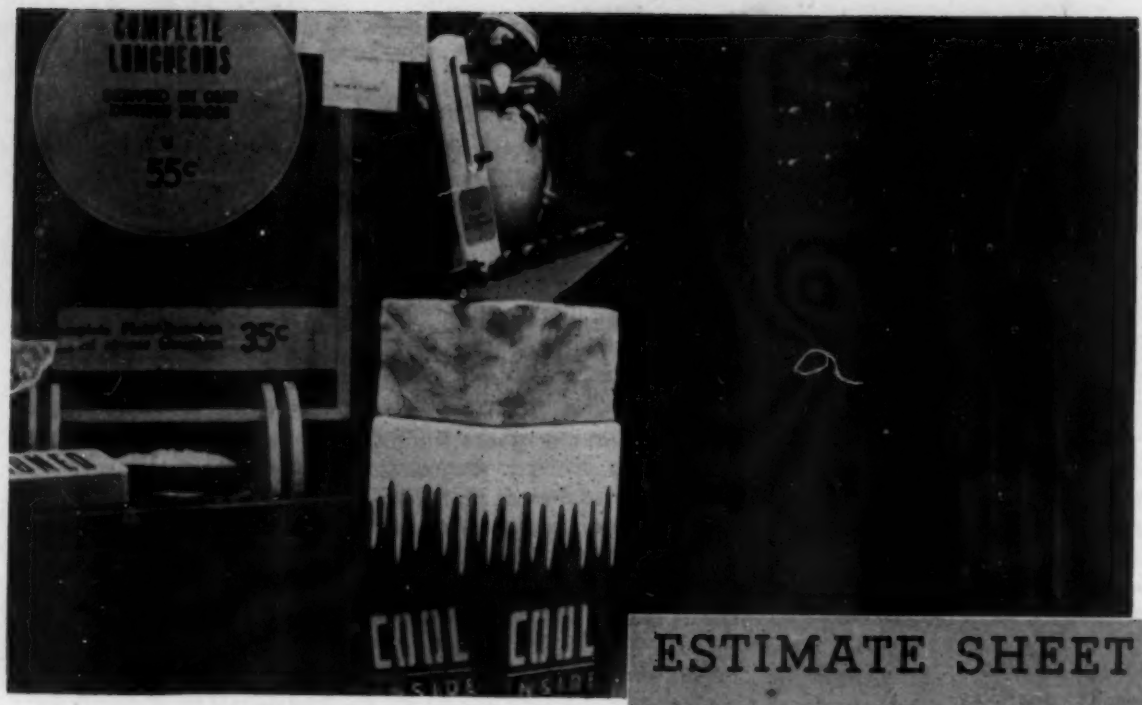
The 1946 semi-annual meeting of the American Society of Heating and Ventilating Engineers will be held June 17 to 19 in Montreal. The society secretary is A. V. Hutchinson, 51 Madison Ave., New York 10, N.Y.

Annual Smoke Prevention Meeting June 23-26

The 1946 annual meeting of the Smoke Prevention Association of America will be held June 23 to 26 at the Nicollet hotel, Minneapolis, Minn., according to an announcement by Frank A. Chambers, secretary-treasurer of the association, whose headquarters is at City Hall Square Bldg., Chicago 2, Ill.

Welding Society Plans Annual Meeting

The 1946 annual meeting of the American Welding Society will be held in Atlantic City during the week of November 4. Details of the program will be announced at a later date by the society, whose headquarters is at 33 W. 39th St., New York 18, N. Y.



ESTIMATE SHEET AIDS STORE COOLER SIZING

ACRMA Form Gives Factors for Selecting Air Conditioners

THE COOLING load estimate form recently copyrighted by the Air Conditioning and Refrigerating Machinery Association, 717 Southern Bldg., Washington 5, D. C., has been designed to list all the factors to be considered in adequately air conditioning a space such as a store, restaurant, office, etc., by means of self-contained air conditioners.

ACRMA's cooling load estimate form is designed mainly as an aid in the utilization of "store coolers" through the 5 ton size, but may be employed also in figuring jobs requiring larger self-contained air conditioners. General use of the form will minimize the number of under-capacity air conditioning installations, according to the association.

The room air conditioner section of the ACRMA expects to publish soon a form of selection procedure especially adapted for room air conditioners.

Instructions for Use of Form

Following are the instructions furnished with the cooling load estimate form for store coolers:

I) Summer outside design temperatures may be obtained for the principal cities of the United States by referring to the Heating, Ventilating, Air Conditioning Guide, published by the American Society of Heating and Ventilating Engineers.

II) Insert the information called for in the six job identification lines at the top of the Estimate Form.

III) The following numbered paragraphs refer to the item numbers of the estimate form.

YOU CAN'T select the right capacity for an air conditioning installation by picking a number out of a hat. Even when using units, a survey must be made of the load conditions so that the equipment will be properly sized for the job to be done. . . . This new estimate form has been designed to facilitate the selection of store coolers through the 5 ton size; a similar procedure for room air conditioners is expected to be published soon by the association

1) Insert the number of persons to normally occupy the space after the air conditioning is installed. If all the people are engaged in the same activity, the number should be placed on the proper line. If some are more actively engaged than others, the total number would be properly divided on the two lines. If it is a space which would be occupied by a large number of people for only a few minutes' duration and then a smaller number for the remaining time, use the largest number which would be present for approximately 15 min duration.

2) Insert the maximum total square feet of window area on any one wall of the space exposed to direct sunshine. Refer to Table A and select the proper factor which must be inserted in space indicated. If all of the windows are on the north wall or on a wall shaded completely from the sun by an adjacent building, no figure will appear in this item.

3) Insert the total number of watts in use, not including the watts consumed by appliances listed in Table B. Lights in store showcases contribute heavily to the load and must not be neglected.

COOLING LOAD ESTIMATE

Recommended Practice for Members of Self-Contained Air Conditioner Section of

AIR CONDITIONING AND REFRIGERATING MACHINERY ASSOCIATION, INC.

This estimate is suitable for comfort air conditioning jobs not requiring specific conditions of temperature and humidity.

Copyright 1946

Customer _____ Buyer _____

Address _____ Space to be used for _____

Estimate by _____ Date _____ Approval _____ Date _____

1. People	(Number Sitting or Moving Slowly)		× 400 =	
	(Number Working, Dancing or Similar Activity)		× 660 =	
2. Windows Exposed to Sun (Figure this item for the one sun exposure having largest window area)	(Total Sq. Ft.)	×	A =	
3. Lights and Electrical Appliances (Include in this item only those appliances not listed in Table B)	(Total Watts in Use)		× 3.4 =	
4. Other Heat Sources			B =	
5. Sub-total—Sum of Items 1 thru 4			= →	
6. Windows Not Included in Item 2	(Total Sq. Ft.)	×	C =	
7. Walls and Partitions	Sq. Ft.—Windows	Sq. Ft. = ×	C =	
	Sq. Ft.—Windows	Sq. Ft. = ×	C =	
	Sq. Ft.—Windows	Sq. Ft. = ×	C =	
8. Floor	(Total Sq. Ft.)	×	C =	
9. Ceiling	(Total Sq. Ft.)	×	C =	
10. Ventilation or Infiltration	(Cu. Ft. per Min.)	D ×	E =	
11. Sub-total—Sum of Items 6 thru 10			= →	
12. Total Btu. per hour Cooling Load to be used for Selection of Unit—Sum of Items 5 and 11				=

COOLING LOAD FACTORS

WINDOWS EXPOSED TO SUN—SOLAR RADIATION FACTORS FOR DIFFERENT ORIENTATIONS TO BE INSERTED AT A

Direction Windows Face	NE	E	SE	S	SW	W	NW
Clear Glass (Single or Double) No Protection	110	180	160	105	160	180	110
Shaded Completely by Awnings	30	50	45	30	45	50	30
Light Colored Inside Shades or Venetian Blinds	65	110	95	60	95	110	65
Glass Brick No Protection	44	72	64	42	64	72	44

OTHER HEAT SOURCES TO BE INSERTED AT B

Beauty Parlors	Number of Operators	× 2000 =	
Electric Motors	Total Name Plate HP	× 2800 =	
†Gas Burners	Number	× 6000 =	
†Glass Coffee Makers	Number	× 900 =	
†Coffee Urns—Gas or Electric	Coffee Capacity in Gallons	× 1400 =	
†Steam Tables—Electric	Sq. Ft. Area of Top	× 550 =	
†Steam Tables—Gas	Sq. Ft. Area of Top	× 1300 =	
Additional Heat Sources		BTU/Hr. =	

†Factors for appliances equipped with hood and positive exhaust should be reduced by 50%. Insert Total At B _____

WINDOWS, WALLS, FLOORS AND CEILING TRANSMISSION FACTORS FOR VARIOUS OUTSIDE DESIGN TEMPERATURES—INSERT AT C

Outside Dry Bulb °F	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
Windows (No Sun)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Walls—Heavy Masonry	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	6	7
Walls—Average Masonry	3	3	3	3	4	4	4	4	5	5	5	6	6	6	6	7	7	7	7
Walls—Insulated Masonry or Frame	1	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	5
Walls—Average Frame	2	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7
Partition—Inside, Single Thickness	5	5	6	7	7	8	8	8	9	10	10	11	11	12	12	13	14	14	15
Partition—Inside, Double Thickness	3	3	3	4	4	4	4	5	5	5	6	6	6	6	7	7	7	8	8
Partition—Display Window Back	11	12	13	13	14	14	15	15	16	17	17	17	18	19	19	19	20	21	21
Glass Brick (No Sun Exposure)	4	4	5	5	5	6	6	7	7	8	8	8	9	9	10	10	10	11	11
Floor	2	2	2	2	3	3	3	3	4	4	4	4	4	4	5	5	5	5	5
Ceiling Under Unventilated Attic*	11	11	11	12	12	12	12	13	13	13	13	14	14	14	15	15	15	15	16
Ceiling Under Ventilated Attic*	7	7	8	8	9	9	10	10	10	11	11	12	12	13	13	14	14	14	15
Ceiling Under Flat Roof*	13	13	14	14	14	15	15	15	16	16	16	17	17	17	18	18	18	19	19
Ceiling Under Occupied Floor*	2	3	3	3	3	3	4	4	4	5	5	5	5	6	6	6	6	7	7

*Adjust factor selected from this table if Ceiling is insulated. Example: 4" Insulation—0.2 × Selected Factor = Adjusted Factor.

1" Insulation—0.4 × _____ = _____, 2" Insulation—0.3 × _____ = _____, 4" Insulation—0.2 × _____ = _____.

VENTILATION OR INFILTRATION QUANTITY TO BE INSERTED AT D

Calculate Requirements for Both Ventilation and Infiltration, and Use Larger Quantity Cu. Ft. per Minute (CFM). Use No Less CFM than Required by Local Ordinance, and no less than amount drawn from space by exhaust fans if used.

VENTILATION REQUIREMENTS

SMOKING	No. OCCUPANTS		C.F.M.
None	_____	× 7½ =	_____
Light	_____	× 15 =	_____
Heavy	_____	× 40 =	_____

INFILTRATION

(H) = Room Height (L) = Length (W) = Width (G) = Wall Factor

Room with one outside wall (G) = 1

Two outside walls (G) = 1.5

Three or more outside walls (G) = 2

$$\text{C.F.M.} = \frac{(H) \times (L) \times (W) \times (G)}{60} = \_\_\_\_$$

VENTILATION OR INFILTRATION FACTOR FOR VARIOUS OUTSIDE DESIGN TEMPERATURES IN °F.W.B. TO BE INSERTED AT E

Outside Wet Bulb °F	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Factor	0	1	3	5	8	11	14	17	20	23	27	30	33	37	41	45	49

4) Use Table B for calculating the heat load due to gas and electrical appliances and motor driven apparatus. Insert the total in the space indicated in Item 4.

5) After checking the extensions of the first four items, add them and carry this subtotal to space at right.

6) Insert the total square feet of windows not included in Item 2. In Table C select the factor for these windows under the design outside dry bulb temperature previously established. Insert this factor in space indicated in Item 6.

7) Three lines are provided in this item as it is quite possible that several wall constructions may be used on a particular space. In each case subtract the area of the windows from the total wall or partition area and insert the total net wall or partition areas. In Table C select the proper wall or partition factor shown under the design temperature already established. Insert these factors on the proper lines at the spaces indicated in Item 7.

8) Insert the total square feet of floor area. Refer to Table C for the factor to be inserted in the space indicated.

9) Insert the total square feet of ceiling area. Refer to Table C for the factor which fits the conditions of the building. Adjust this factor if ceiling is insulated and insert the factor or adjusted factor in space indicated.

10) Use Table D for calculating the ventilation or infiltration cfm. The total number of occupants must equal those used in Item 1. The infiltration does not include the cfm which would enter space if doors or windows are permitted to remain open. Insert the cfm in space provided.

Refer to Table E and select the factor shown under the design outside wet bulb temperature previously established. Insert this factor in space indicated.

11) After checking the extensions of Items 6 through 10, add them and carry this subtotal to space at right.

12) Add subtotals, Items 5 and 11. This total is the Btu per hr cooling load.

[Note: Non-members of ACRMA wishing to reprint this estimate form and instructions must obtain permission from the association.]

Reports on U-Boat Refrigeration Features, German Tank Air Conditioning Studies

THE PRINCIPAL German advances in the refrigeration field during the war are revealed by a U. S. investigator to have been made in development of refrigeration equipment for U-boats, for aircraft testing and military food preservation, and in research on air conditioning for tanks, the U. S. Department of Commerce office of the publication board said last month.

Information on these and other German developments is presented in report No. 205, German Refrigeration Industry, prepared by E. T. Simonson, of the U. S. Engineers. The report contains 64 pages, including 37 pages of illustrative material.

Refrigeration installations in U-boats are reported to have been so efficient that U-boats could travel from Germany to Japan, operate there for two months, and return to Germany without having to take on fresh water for the crew.

The main features of German U-boat refrigeration equipment, as described in the report, are:

1. No bypasses were used around the automatic expansion valves.

2. Air cooling coils and condensers were constructed of zinc plated steel, and remarkable performance records reportedly were obtained on this type of construction for condensing purposes.

3. A panel board, with simple, hand operated valves for reversing the cycle of operations, was assembled with the equipment.

Aircraft Testing

German refrigeration installations for aircraft testing, particularly for high altitude research and development, are reported to have been excellent. Descriptions of testing setups for aircraft engines, together with diagrams, are contained in the report. An unusually large and complicated test setup for engines under conditions of temperature approaching —40 F or lower, at Volkenrode, Germany, is described in particular detail.

The German army is reported to have been fed efficiently by means of a highly developed system of cold storage plants, located in almost every large city in Germany. Immense quantities of food were stored in these large plants and transported quickly and easily from the interior to combat troops in the east and west. No failure or breakdown of this system occurred until after the Allied crossing of the Rhine. A special type of small refrigerator, with a capacity of 16 cubic feet, was moved with the troops and used in the final step of military food distribution.

After two years of research on the problem of tank air conditioning, the Germans concluded that tanks needed to be air conditioned only for the radio operator and driver, and that this could be accomplished by cooling the heads of the men, since research results showed that the veins in the temple were the critical points of the body with respect to ability to withstand heat.

Too Late

Cooling of the head was to have been accomplished by means of a transparent plastic hood, extending down over the head and shoulders. Conditioned air was to have been delivered through the hood. This was expected to permit men in tanks to withstand desert temperatures. Research was not completed until after the North African campaign, however, and practical application of the results was not made by the Germans.

Though the German refrigeration industry made advances along these lines, it developed no new compressor design techniques or new refrigerants during the war, according to the U. S. investigator.

Report No. 205 may be purchased for 50c in Room 2065, Commerce Building, or by mail. Mail orders should be accompanied by check or money order, made payable to the Treasurer of the United States, and addressed to the Office of the Publication Board, U. S. Department of Commerce, Washington 25, D. C.

Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

Physiological Response of Subjects Exposed to High Effective Temperatures and Elevated Mean Radiant Temperatures

By Clark M. Humphreys,* Cleveland, Ohio, Oscar Imalis,** and Carl Gutberlet,† Pittsburgh, Pa.

JUST PRIOR to and during the war, the ASHVE Research Laboratory, then located in Pittsburgh, Pa., carried on a number of research projects for the U. S. Navy, Bureau of Ships. The results of this work have recently been released for publication. This paper is an abstract of a longer report submitted to the Navy under the same title.

Objective and Scope

The objective of this research project was to determine the physiological reactions of men exposed for four hours to hot atmospheres and surrounded by hot surfaces. The study included tests at Effective Temperatures ranging from 80 to 95 deg, with relative humidities of 30, 50, and 70 per cent, and mean radiant temperatures up to 40 deg above the dry-bulb temperature of the air.

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**Former Research Physicist, ASHVE Research Laboratory.
†Former Asst. Research Engineer, ASHVE Research Laboratory.

Presented at the 52nd Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, New York, N. Y., January 1946.

Definition of Terms

The *Effective Temperature* (ET) is an arbitrary index which combines into a single value the effect of temperature, humidity, and the movement of air, on the degree of warmth or cold felt by the human body. The numerical value is that of the temperature of still, saturated air which would induce an identical sensation of warmth. The full range of conditions included in this study is shown on the Effective Temperature Chart, Fig. 9.

The *Mean Radiant Temperature* (MRT) is another factor, in addition to those included in the definition of Effective Temperature, which affects man's feeling of warmth. It is defined as the uniform surface temperature of an enclosure at which one would exchange the same amount of energy with the enclosure by radiation as at the non-uniform wall temperatures found in practice.

The MRT Elevation, as used in this report, is the excess of the mean radiant temperature over the dry-bulb temperature of the air.

Description of the Test Room

Tests were conducted in one of the Laboratory's psychrometric rooms, to which certain alterations were made to adapt it to this study. To obtain elevated mean radiant temperatures, radiant panels were installed on all four walls of the room. Each panel consisted of a metal sheet, to the back of which a copper coil was soldered. The panel temperature was controlled by varying the pressure of the steam supplied to the coil.

To reach the higher MRT elevations desired for the tests, it was necessary to install reflective surfaces on the floor, on the ceiling, and on the walls below the radiant panels. High MRT elevations were more difficult to secure at the higher relative humidities because of the semi-opaqueness of water vapor to radiant heat.

Air from conditioning equipment in an adjoining room was delivered to a plenum chamber which extended over the greater part of the ceiling of the test room. From this chamber it was discharged above

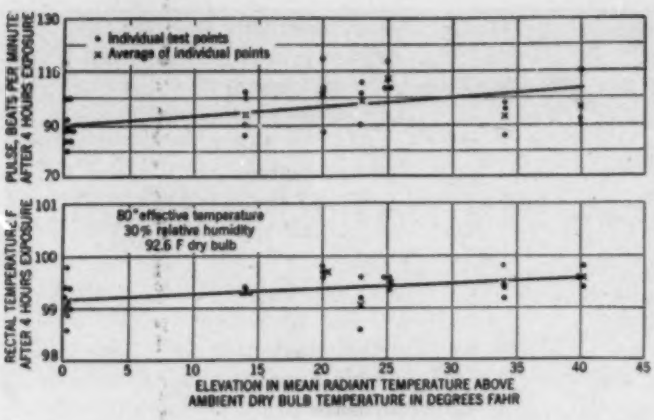
PULSE, BEATS PER MINUTE AFTER 4 HOURS EXPOSURE
• Individual test points
× Average of individual points
80° effective temperature
30% relative humidity
92.6 F dry bulb
RECTAL TEMPERATURE, F AFTER 4 HOURS EXPOSURE
ELEVATION IN MEAN RADIANT TEMPERATURE ABOVE AMBIENT DRY BULB TEMPERATURE IN DEGREES FAHR

Fig. 1—Effect of mean radiant temperature on pulse and rectal temperature for 80 deg ET and 30 per cent RH

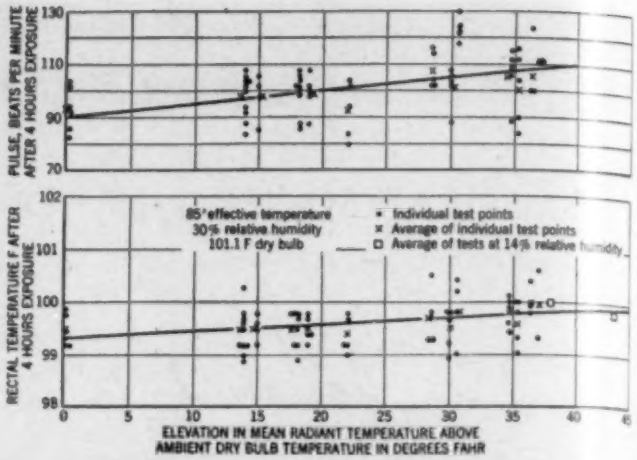
PULSE, BEATS PER MINUTE AFTER 4 HOURS EXPOSURE
85° effective temperature
30% relative humidity
101.1 F dry bulb
• Individual test points
× Average of individual test points
□ Average of tests at 14% relative humidity
RECTAL TEMPERATURE F AFTER 4 HOURS EXPOSURE
ELEVATION IN MEAN RADIANT TEMPERATURE ABOVE AMBIENT DRY BULB TEMPERATURE IN DEGREES FAHR

Fig. 2—Effect of mean radiant temperature on pulse and rectal temperature for 85 deg ET and 30 per cent RH

the reflective ceiling and entered the occupied area through an opening extending along all four sides of the room. A part of the air was recirculated, and the remainder was exhausted to the surrounding rooms.

Instruments

Globe Thermometer

The mean radiant temperature of the room was determined by the use of 6 in. diameter unheated globe thermometers located 48 in. above the floor.

The MRT readings were calculated from the globe readings, air temperature, and air velocity, using Bedford's equation.[1]

Hot-wire Anemometer

The air movement in the test room was measured with a hot-wire anemometer.

Aspirated Thermocouple

The dry-bulb temperature of the air in the test room was measured by a thermocouple located in a thermos bottle through which room air was drawn by a small fan. The temperature thus obtained was used in the calculation of the room MRT as mentioned above. Both the thermos bottle and fan were completely covered with aluminum foil to reduce the effect of radiation.

Thermocouples

All thermocouples used in these tests were made of calibrated No. 36 copper and constantan wire. A precision-type potentiometer was used to measure the emf of the various thermocouple circuits.

Clinical Thermometers

Clinical thermometers were used to determine rectal and oral temperatures of the subjects.

Wet-Bulb Thermometers

Wet-bulb temperatures were taken with a mercurial thermometer, the bulb of which was covered with a water saturated wick. The thermometer was inserted into the exhaust air duct.

Subjects

The study logically divides itself into two parts because of the fact that two groups of subjects were used. The first and major part of the study, which included approximately 75 per cent of the tests, was made with a group of 36 male civilian subjects between 17 and 22 years of age. The latter 25 per cent of the tests were made with a group of seven enlisted men from the Navy who were assigned to the Laboratory to serve as subjects. Except for a later discussion of acclimatization, this paper will deal only with the first group of tests.

As mentioned previously, a total of 36 civilian subjects were used. However, the great bulk of the data was obtained with eight subjects who were selected from the larger group during the early tests. All of these eight subjects were 18 years of age. Before being accepted, each subject was required to pass a physical examination based on standards for Navy enlistment. The basal metabolism of each subject was also determined as further evidence of good health.

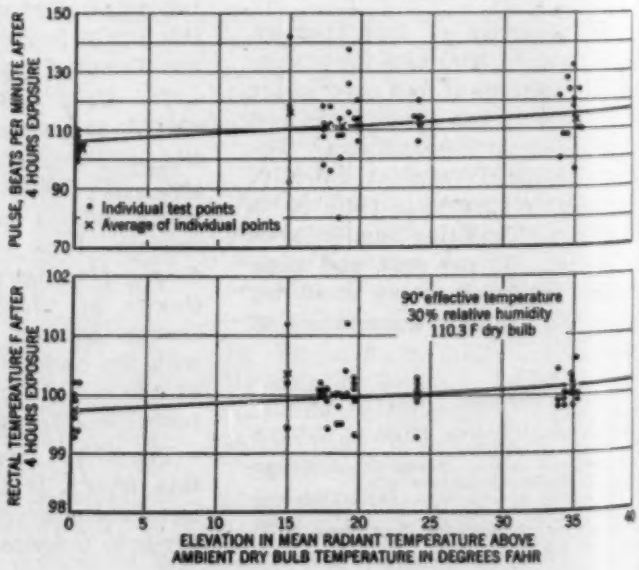
PULSE, BEATS PER MINUTE AFTER 4 HOURS EXPOSURE
• Individual test points
× Average of individual points
90° effective temperature
30% relative humidity
110.3 F dry bulb
RECTAL TEMPERATURE F AFTER 4 HOURS EXPOSURE
ELEVATION IN MEAN RADIANT TEMPERATURE ABOVE AMBIENT DRY BULB TEMPERATURE IN DEGREES FAHR

Fig. 3—Effect of mean radiant temperature on pulse and rectal temperature for 90 deg ET and 30 per cent RH

[1] T. Bedford and C. G. Warner, *Journal of Hygiene* (London) Vol. 34, 1934, pp. 458-473.

Test Procedure

During the tests the subjects wore regulation Navy clothing issued to men working in hot spaces, consisting of sleeveless shirt, trousers, socks, and shoes.

Before entering the test room, subjects were required to remain at rest for at least one hour in a control room maintained at 77 deg ET. During this time, a light lunch was served for the subjects, all of whom consumed approximately equal amounts. The purpose of this control room was to eliminate the effect of varying exertion or weather en route to the laboratory, and thus to make sure that all the subjects were at equilibrium with a common environment. At the end of the equalizing period, the subjects passed from the control room to the nearby test room, which had previously been brought to the desired conditions.

To simulate conditions in the fireroom of a ship, it was considered desirable to have the subjects engaged in light work of a type which would keep them alert and attentive throughout the testing period. To accomplish this, a definite program of activity was planned and carried out with the aid of a simple chance machine. As the activity of the subjects in tests of this nature has an important influence on the results obtained, the operation is described in detail.

Each subject was given a marble and six small numbered weights of

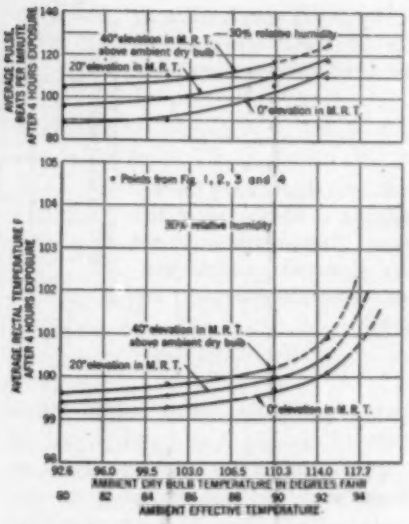
AVERAGE PULSE, BEATS PER MINUTE AFTER 4 HOURS EXPOSURE
40° elevation in M.R.T. above ambient dry bulb
20° elevation in M.R.T.
0° elevation in M.R.T.
30% relative humidity
AVERAGE RECTAL TEMPERATURE F AFTER 4 HOURS EXPOSURE
• Points from Fig. 1, 2, 3 and 4
30% relative humidity
40° elevation in M.R.T. above ambient dry bulb
20° elevation in M.R.T.
0° elevation in M.R.T.
92.6 96.0 99.5 103.0 106.5 110.3 114.0 117.7
AMBIENT DRY BULB TEMPERATURE IN DEGREES FAHR
80 82 84 86 88 90 92 94
AMBIENT EFFECTIVE TEMPERATURE

Fig. 5—Variation of rectal temperature and pulse with effective temperature for 0, 20, and 40 deg MRT elevation

the same distinctive color. Beside the chance machine was a small table on which six numbered areas were defined. Each subject dropped his marble into the chance machine, which was so constructed that the marble would be returned in from one-half to five minutes. When a marble emerged, its owner immediately threw two dice, one of which indicated which one of several weights should be moved, the other, where it should be placed on the table. When the task was completed, the subject recorded the time and move made and again dropped the marble into the machine.

There was only one chair in the test room for the five subjects. The subject completing a move at the machine took the chair, and the others progressed in a pre-arranged order to new locations marked on the floor of the room. Thus each man was seated, on the average, 20 per cent of the time. This rotation also assured exposures of equal severity for all subjects.

Tests were normally of four-hour duration to conform to the customary Navy watch period. However, if a subject's pulse exceeded 140 beats per minute, or his rectal temperature 102 F, he was removed from the test.

Subjects were permitted to drink as much water as they desired, but were required to drink it at least 10 min before temperatures were to be taken. In accordance with instructions from the Navy, a sodium chloride concentration of 0.15 per cent by weight was maintained in the drinking water. The weight of water consumed by each subject was recorded.

Collection of Data

The following physiological data and observations were taken during each test:

1. Body temperature, rectal and oral.
2. Pulse rate.
3. Weight of subjects before and after test.
4. Weight of water consumed and urine expelled by each subject.
5. Blood pressure.

Blood pressure was taken before and after each 4-hour test. Body temperatures and pulse rate were taken at 15-min intervals.

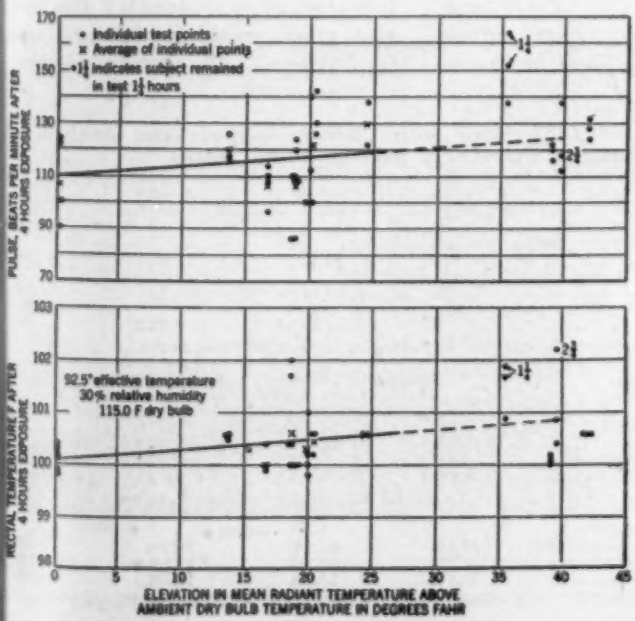
• Individual test points
x Average of individual points
•1½ Indicates subject remained in test 1½ hours
PULSE, BEATS PER MINUTE AFTER 4 HOURS EXPOSURE
92.5° effective temperature
30% relative humidity
115.0 F dry bulb
RECTAL TEMPERATURE F AFTER 4 HOURS EXPOSURE
ELEVATION IN MEAN RADIANT TEMPERATURE ABOVE AMBIENT DRY BULB TEMPERATURE IN DEGREES FAHR

Fig. 4—Effect of mean radiant temperature on pulse and rectal temperature for 92.5 deg ET and 30 per cent RH

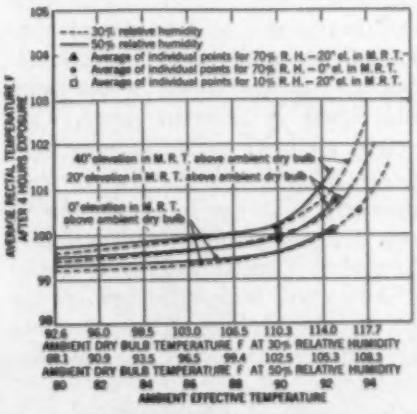
30% relative humidity
50% relative humidity
Average of individual points for 70% R.H. – 20° el. in M.R.T.
Average of individual points for 70% R.H. – 0° el. in M.R.T.
Average of individual points for 10% R.H. – 20° el. in M.R.T.
AVERAGE RECTAL TEMPERATURE F AFTER 4 HOURS EXPOSURE
40° elevation in M.R.T. above ambient dry bulb
20° elevation in M.R.T. above ambient dry bulb
0° elevation in M.R.T. above ambient dry bulb
92.6 96.0 99.5 103.0 106.5 110.3 114.0 117.7
AMBIENT DRY BULB TEMPERATURE F AT 30% RELATIVE HUMIDITY
88.1 90.9 93.5 96.5 99.4 102.5 105.3 108.3
AMBIENT DRY BULB TEMPERATURE F AT 50% RELATIVE HUMIDITY
80 82 84 86 88 90 92 94
AMBIENT EFFECTIVE TEMPERATURE

Fig. 6—Variation of average rectal temperature after 4 hours exposure for 30, 50, and 70 per cent RH and 0, 20, and 40 deg MRT elevation

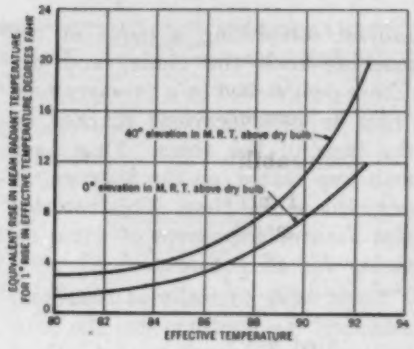
EQUIVALENT RISE IN MEAN RADIANT TEMPERATURE FOR 1° RISE IN EFFECTIVE TEMPERATURE DEGREES FAHR
40° elevation in M. R. T. above dry bulb
0° elevation in M. R. T. above dry bulb
EFFECTIVE TEMPERATURE

Fig. 7—*(left)* Evaluation of effect of MRT elevation in terms of effective temperature

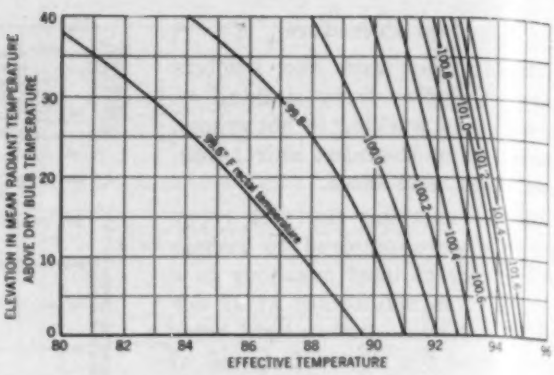

Fig. 8—*(right)* Chart for determining combination of Effective Temperature and MRT elevation which produces same physiological reactions

The following physical data were taken throughout each test:

1. Dry-bulb temperature.
2. Wet-bulb temperature.
3. Globe thermometer readings.
4. Air velocity.

Presentation of Data

Tests were made at 30, 50, and 70 per cent relative humidity. The data obtained at 30 per cent, showing the effect of environmental conditions on pulse and rectal temperature, are presented in Figs. 1 to 5. In these figures, each dot indicates the reaction of a single subject in one test. A series of not more than five dots in a vertical line indicates the reactions of the group of subjects during one test. There were never more than five subjects used at any one time; where more than five points appear in a vertical line, it indicates two or more tests made at the same conditions. The average value for each test or group of tests is indicated by an X.

It will be noted that the temperatures indicated by the individual points seldom vary more than 0.75 F from the average temperature as shown by the curve. This is a usual range for such physiological data and is due not only to the physiological inequalities of individuals, but also to variations in the same individual at different times.

The effect of mean radiant temperature on pulse and rectal temperature is shown in Fig. 1 for 80 deg ET and 30 per cent relative humidity. Similarly, Figs. 2, 3, and 4 show these same relationships for 85, 90, and 92.5 deg ET, respectively, with 30 per cent relative humidity.

Fig. 5 shows the variation in rectal temperature and pulse with Effective Temperature for 0, 20, and 40 deg MRT elevations. It is constructed, not directly from test data, but from curve points taken from Figs. 1, 2, 3, and 4, all of which are for 30 per cent relative humidity. For convenience, the abscissae are given in corresponding dry-bulb as well as Effective Temperatures.

Similar sets of curves were plotted for tests at 50 and 70 per cent relative humidities, but for lack of space have been omitted from this paper. Fig. 6, however, presents a summary of all of the tests. The dotted lines in this figure were taken from Fig. 5, and the solid lines from a similar figure for the tests at 50 per cent relative humidity. Tests at 70 per cent relative humidity were made at only the higher effective temperatures, and their results are indicated on Fig. 6 by appropriate dots, rather than curves.

Unless otherwise noted on the figures, the plotted points on Figs. 1 to 4, inclusive, represent conditions of pulse and rectal temperature at the end of the 4-hour test periods. It sometimes became necessary during tests at the higher Effective Temperatures to remove a subject from the test room before 4 hours had elapsed, due to excessive body temperature or pulse, or because of exhaustion. In such cases, where the subject had remained in the test room during the greater part of the test period, and where his temperature and pulse had risen at a reasonably uniform rate up to the time of his removal, the data have been extrapolated to determine the probable values for a 4-hour exposure. Such an extrapolated point is indicated by an open circle in the figures. If the subject was removed because of a sudden and very rapid rise in pulse or temperature, no attempt was made to extrapolate the data. However, in some cases the pulse and temperature for such a subject are indicated on the charts, but beside the dots will appear the number of hours which elapsed before the subject was removed from the test room and the readings taken.

Even under the most favorable conditions the accuracy of extrapolated physiological data is questionable. Including records for only those subjects who were able to withstand the high temperatures for 4 hours, and deleting the rest, also gives results which are open to criticism. In certain respects,

Table 1—Summary of Tests Made with Civilian Subjects and Analysis of Causes of Removal of Subjects From Tests

Effective Temperature deg.	90	92.5	93.7	95
Number of tests at this ET	31	21	9	9
Total number of subjects taking part in these tests	143	101	41	42
Number of subjects removed for all causes	17	37	18	33
Percentage of subjects taking part who were removed	11.9	36.6	43.9	78.5

Analysis of Causes for Removal of Subjects from Tests

Cause of Removal	Number of subjects and the percentage of the total number of subjects taking part in tests who were removed for each cause			
A. High pulse	8 (5.6%)	25 (24.8%)	13 (31.7%)	24 (57.1%)
B. High rectal temperature	7 (4.9%)	6 (5.9%)	2 (4.9%)	3 (7.1%)
C. Exhaustion	2 (1.4%)	6 (5.9%)	3 (7.3%)	6 (14.3%)
Cause of Removal	The percentage of the total number removed who were removed for each cause			
A. High pulse	47.0%	67.6%	72.2%	72.7%
B. High rectal temperature	41.2%	16.2%	11.1%	9.1%
C. Exhaustion	11.8%	16.2%	16.7%	18.2%

the points which would thus be omitted are of particular importance. To try to present the most complete picture possible, curves have been extended on the basis of extrapolated and "short period" points. However, such extensions are shown with dotted, rather than solid lines, and the values indicated by the dotted portions of the curves can be considered only approximate.

Referring again to Fig. 6, it is of interest to note the close agreement of curves and points for the several relative humidities. The small differences shown here become entirely negligible when compared with the spread of points found for each test. This agreement indicates that the results of this project check very closely the earlier work done in the development of the Effective Temperature Charts.

An evaluation of the effect of MRT elevation in terms of Effective Temperature is presented in Fig. 7. It is apparent from this figure that the effect of a rise in MRT on physiological reactions is dependent upon both the Effective Temperature of the surrounding air and the amount of MRT elevation. The curves in the figure were obtained from the slopes of the curves in the preceding figures. For example, at 84 deg ET and 40 deg elevation in MRT, a 4 deg rise in MRT is equivalent to a 1 deg ET change. Similarly, at a constant ET of 90 deg, and with MRT elevations of 0 and 40 deg, 7.5 deg and 11 deg MRT rises respectively are required to produce a one degree change in the Effective Temperature.

In Fig. 8 rectal temperature curves are plotted using Effective Temperature and MRT elevation as coordinates. From this figure it is possible to determine various combinations of Effective Temperature and MRT elevation which produce the same physiological reactions. For example, a combination of 87 deg ET and 30 deg MRT elevation produces a body temperature of 99.8 F. Following down this body temperature line, it is found that a combination of 91 deg ET and 0 MRT elevation is exactly equivalent to the first set of conditions in its effect on body temperature.

The effect of radiant heat on physiological reactions is much less than had been anticipated. This is particularly true at the higher Effective Temperatures.

Endurability of Conditions

Table 1 presents a summary of all tests made on civilian subjects and gives an analysis of the causes for removal of subjects from the test room before the end of the scheduled 4-hour test. It is interesting to note that as the Effective Temperature increased a greater percentage dropped out because of high pulse rate and exhaustion, and a smaller percentage was removed because of high rectal temperature. "Exhaustion" in this analysis includes extreme weakness, sickness, severe headache, etc.

Weight Loss

An analysis of weight loss by perspiration was made in much the same manner as body temperature and pulse were analyzed in Figs. 1 to 6. As might be expected, the weight loss increased with increases in Effective Temperature and MRT elevation. The average weight loss at 92.5 deg ET and 40 deg MRT

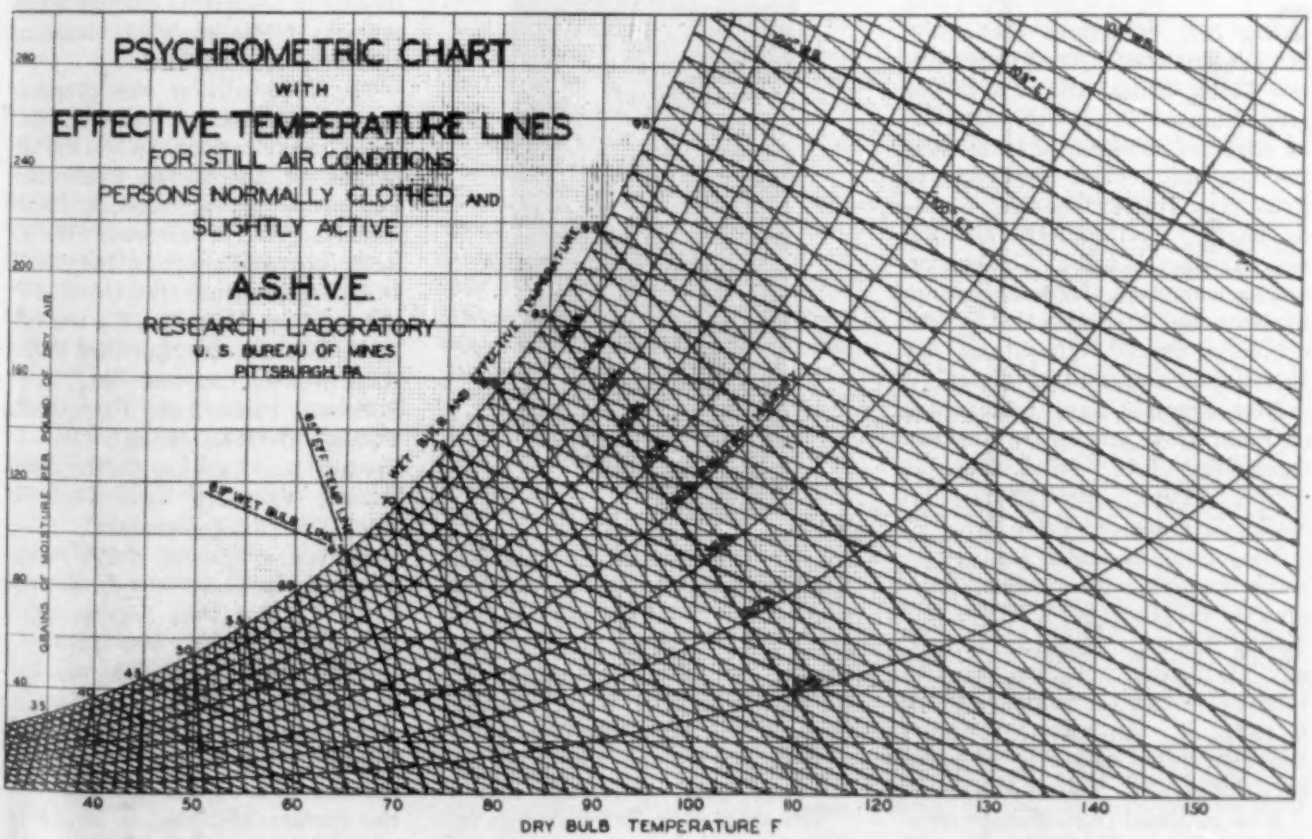

Fig. 9—ASHVE Effective Temperature Chart for persons normally clothed and slightly active in still air

elevation was found to be about 4.5 per cent of the subject's entering weight. Most of this loss, however, was made up by the water consumed during the test. The difference between the entering and leaving weight of a subject seldom exceeded two pounds.

Acclimatization

From the very beginning of the study it was recognized that the ideal subjects for the tests would be men who had actually had experience in the fire rooms or engine rooms of naval vessels. It was only because Navy subjects were unavailable that civilian subjects were used for the major part of the work.

One of the chief arguments advanced in favor of Navy subjects was that centering around the subject of acclimatization. It was thought possible that men long accustomed to work in hot spaces would be less affected by the heat. Since the greater part of the study with civilian subjects was made during the cold winter months, the possible effect of acclimatization became doubly important.

Early in May, seven enlisted men from the battleship *Arkansas* were assigned to the Laboratory to serve as subjects. All of the men were from the fire-room and engine-room crews and were sent to the Laboratory the day after their ship docked. However, as it was later learned, their ship had been on patrol duty in the North Atlantic rather than in the tropics, and the conditions under which the men had stood watch were not too severe.

On the assumption that these men were thoroughly acclimatized, they were placed at once in rather severe tests. It was immediately evident that they were not accustomed to such conditions, for their pulse rate and body temperatures reached considerably higher values than those of civilian subjects in tests of equal severity. The group participated in a test each day, and for at least two weeks showed steady and appreciable improvement. At the end of that time they were easily able to remain in the test room for four hours under environmental conditions which none had been able to endure for four hours at the beginning of the period.

Summary

1. Within the range of conditions considered in this study, all variables in a man's environment which affect his physiological reactions may be expressed in terms of Effective Temperature and mean radiant temperature elevation. When physiological reactions are plotted against Effective Temperature, the results are practically the same for various values of relative humidity.

2. The effect of an increase in MRT elevation on physiological reactions is dependent upon the values of ET and MRT elevation. This is shown in Fig.7.

3. The effect of radiant heat on physiological reactions decreases as the Effective Temperature increases and becomes surprisingly small as the upper limits of endurability are reached.

4. By repeated exposure to hot environments for periods of 4 hours or less each day, a person can acquire a considerable degree of acclimatization. The acclimatization process may require a period of two weeks or longer.

THE 1946 GUIDE

THE 24th edition of the HEATING, VENTILATING, AIR CONDITIONING GUIDE, which will be available for shipment in March, contains 51 chapters of technical text under the general section headings of Principles, Human Reaction to Atmospheric Environment, Heating and Cooling Loads, Combustion and Consumption of Fuels, Heating Systems and Equipment, Air Conditioning, Special Applications, and Installation and Testing Codes.

New chapters have been added on Fluid Flow, and on Owning and Operating Costs. More than 75 testing, rating, selecting and installation codes are listed.

Properties of moist air and of water from the most recent cooperative research of ASHVE and Towne Scientific School of University of Pennsylvania are given in tables covering the range —160 F to +212 F. An enlarged Mollier Diagram for Moist Air prepared by John A. Goff is included.

New material from Society sponsored research on air flow in outlets has been added to the chapter

on Air Distribution. A new air friction chart based on studies made at the ASHVE Research Laboratory has been prepared for the chapter on Air Duct Design. To the chapter on Hot Water Heating Systems and Piping has been added a chart showing pipe flow in pounds of water based on friction loss.

The chapter on Refrigeration includes an enlarged presentation of the various refrigeration cycles. Air Contaminants are defined and treated in a separate chapter which contains tables showing maximum allowable concentrations.

The 1946 edition was prepared by 42 members of ASHVE and other organizations under the direction of the Guide Publication Committee: C. S. Leopold, Philadelphia, Pa., *Chairman;* W. C. Bevington, Indianapolis, Ind.; R. S. Dill, Washington, D. C.; C. F. Kayan, New York, N. Y.; the late P. F. McDermott, Manville, N. J.; A. B. Newton, Dayton, Ohio; T. F. Rockwell, Pittsburgh, Pa.; G. H. Tuttle, Detroit, Mich.; W. L. Yerkes, Los Angeles, Calif.; Cyril Tasker, ex-officio, and Carl H. Flink, Technical Secretary.

Modern equipment of 233 manufacturers is illustrated in the enlarged Catalog Data Section which is complete with a cross-index.

THE GUIDE contains 904 pages of technical text, 376 pages of equipment data, and the Roll of Membership of the Society. It matches the size (6 x 9) and appearance of the former editions, is bound in blue cloth cover stamped in gold. The price of THE GUIDE is $6.00.

An Experimental Investigation of the Effect of Change in Atmospheric Conditions and Noise Upon Performance†

By Morris S. Viteles,* Ph.D., Philadelphia, Pa., and Kinsley R. Smith,** Ph.D., State College Pa.

A Study Conducted Under the Auspices of the American Society of Heating and Ventilating Engineers

Introduction

IT IS GENERALLY recognized that major problems arise in providing and maintaining comfortable atmospheric conditions for personnel working in confined spaces on Naval ships, particularly when the latter are cruising in tropical waters. Any attempt to improve atmospheric conditions either by using larger ventilating fans or through mechanical refrigeration immediately involves an increase in the weight of equipment. Weight considerations are extremely important in the design of Naval ships, and an increase in the weight of equipment can be justified only if it will improve the overall performance of the ship as a fighting unit. Moreover, the functioning of ventilating or refrigeration equipment is frequently accompanied by an increase in noise level which may in itself be detrimental to the performance of ship personnel.

Pertinent in this connection is the effect of hot atmospheres and higher noise levels on men in plotting and charting rooms, where a great deal depends upon the speed and accuracy of work and on the morale of personnel engaged in such work. The purpose of the investigation described in this report was to determine the effect of diverse atmospheric and noise conditions upon output, feelings, and physiological functions during the performance of tasks roughly analogous to operations carried on by personnel in the plotting and charting rooms of Naval vessels. The investigation was designed to determine whether the accuracy, speed, and attitudes of personnel could be improved by air conditioning and the extent to which such improvement through reductions of temperature might be counter-balanced by possible adverse effects of increased noise.

Acknowledgments

The general aspects and requirements of the study were outlined by Mr. A. E. Stacey, Chairman of the Committee on Research, American Society of Heating and Ventilating Engineers; Mr. J. H. Walker, Technical Adviser; Dr. F. C. Houghten, Director of Research of the American Society of Heating and Ventilating Engineers; and Cdr. R. M. Watt, Jr., and members of his staff and associates in the U. S. Navy. The experiment was designed and conducted by the authors in consultation with the Committee on Research and Navy personnel and, most particularly, with the assistance of the late Dr. F. C. Houghten, who was responsible for the choice and administration of the physiological measures employed in the study.

The study was carried out in 1940 in the psychrometric rooms of the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, then located in the U. S. Bureau of Mines Building, Pittsburgh, Pa. S. C. Markey, H. T. Olsen, Carl Gutberlet, A. A. Rosenberg, and John Suciu, Jr., of the laboratory staff were largely responsible for maintaining the physical conditions of the study and for collecting the data. They also cooperated in the preliminary analysis of the data, under the direction of the authors, who were responsible for the statistical analysis and who prepared the final report which is summarized in this article.

General Conditions of the Main Experiment

The main experiment involved an analysis of changes in *output, feelings,* and *physiological* state of six subjects[1] who worked on selected experimental tasks six days per week for a period of seven weeks.

Subjects

The subjects were selected from a group of 40 candidates through application of standards designed to provide (1) an experimental group meeting the physical qualifications for acceptance by the Navy, and (2) a group relatively homogeneous from the viewpoint of age, education, general intelligence, and initial scores on the experimental tasks employed in the main experiment. The general characteristics of the group of subjects used in the investigation were as follows:

1. *Physical Conditions:* Passed physical examination for United States Navy. Diagnosed as essentially normal in hearing on basis of complete audiometric examination administered through the co-operation of the Pittsburgh Public School System.
2. *Weight:* From 129¼ lb to 168½ lb.
3. *Height:* From 5 ft 7 in. to 6 ft 2 in.
4. *Age:* From 18 to 21 years.
5. *Education:* High school graduates with no further formal education.
6. *Mental Alertness:* Subjects ranged between *average* and *above average* in general intelligence as measured by the *Otis Self-Administering Test of Mental Ability* (Higher Form). Raw scores ranged from 43 to 55, giving an I.Q. range of from

†This paper presents a detailed summary of a comprehensive report which could not be published in this journal because of space limitations. A limited number of copies of the complete report are available and application should be made to the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

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[1]The investigation was initiated with 8 subjects. Two subjects dropped out during the fourth and fifth weeks. Although replacements were obtained for these subjects, in order that social factors would be held as constant as possible, only data from the 6 subjects who remained throughout the experiment were considered in the analysis.

101 to 113, *i.e.*, within approximately +1 standard deviation from the average.

7. ***Initial Performance on Experimental Tasks:*** The tests, or experimental tasks, used in the investigation were administered, and only those applicants selected who showed no wide deviation from average performance on these tests (as determined from available norms).

Atmospheric Conditions

Atmospheric conditions included effective temperatures of 73 deg (80 F dry-bulb—65.5 F wet-bulb); 80 deg (88 F dry-bulb—73.3 F wet-bulb); 87 deg (98 F dry-bulb—81.5 F wet-bulb), and 94 deg (108.5 F dry-bulb—90.3 F wet-bulb).[2] These temperatures were maintained through the operation of the temperature control room available in the Research Laboratory of the ASHVE.

Noise Levels

Noise levels of 72, 80, and 90 db (decibels) were employed during the main experiment. The source of noise was a fan, installed and operated under conditions specified by U. S. Navy personnel. Electrical transmission was employed in bringing the noise into the experimental room.

Experimental Tasks

The Discrimeter: This task consisted of a large upright disc about 18 in. in diameter, near the top of which was a small window through which a single digit was visible. Below the disc were four keys, one for each finger of the subject. The subject kept the fingers of his right hand upon the keys and pressed the finger corresponding to the digit which was visible in the window. If the wrong key was pressed the mechanism did not respond. Pressing the right key brought into view another digit which was responded to in turn. The score was expressed as the number of correct responses made in 30 min, and was automatically recorded by an electric counter.

The Mental Multiplication Test: In this test was presented a number of multiplication problems calling for the product of a three-digit and a two-digit number. Performance time was one-half hour, the score being determined by the number of correct digits in the answers. An error score could also be computed in terms of the number of incorrect digits in the answers.

The Number Checking Test: This task involved inspecting pairs of numerical series and checking those pairs in which both numbers of the pair were identical.

The Lathe Test: This apparatus duplicated the slide rest of an engine lathe by means of which the cutting tool is controlled. In place of the cutting tool there was an electrified stylus or pointer. The subject traced the stylus in a horizontal plane around a circular pattern by turning the two control handles. Tracing off the pattern counted as an error. Tracing correctly one-sixth of the circle constituted a correct response. Errors and correct responses were recorded automatically by electric counters. Performance time was one hour.

The Typewriter Code Test: A modified typewriter having a shield between its roller and the subject was used. Through this shield could be seen at one time only one letter of a row of letters on a sheet inserted into the typewriter in the ordinary manner. Ten different letters were used and were presented in scrambled order in long rows. For each letter an appropriate key of the ten keys in the top row of typewriter keys was to be pressed. These keys were not the same as the letters, but represented a coded response, one symbol for each letter. The response was made right on the stimulus sheet in the typewriter in the form of a typed symbol. Performance time was one-half hour.

The Locations Test: On each page of this test were large squares containing letters arranged in definite positions in rows and in columns. Around each of these squares were smaller squares or *blocks,* in which dots were located in the same relative position in the small square as was a certain letter in the larger square. The subject wrote over each dot the appropriate letter indicating the corresponding position of the letter in the larger block. Dots correctly located represented the score, incorrect locations represented the error score. Fifteen sheets constituted a test form. Performance time was one-half hour. (This test was an adaptation of a part of the MacQuarrie Test for Mechanical Ability.)

The Pursuit Test: On each page of this test was a number of mazes each consisting of intertwined lines. In each maze 10 lines started at numbered blocks on the left. Each line was to be traced by eye to the block at the right in which it ended. The number of the starting block was to be placed in the block at which the line terminated. The score was represented by the number of lines correctly followed and recorded. Lines incorrectly followed and incorrectly recorded were scored as errors. Performance time was one-half hour. (This task was also an adaptation of part of the MacQuarrie Test for Mechanical Ability.)

Physiological Tests: Physiological tests included pulse rate and oral temperature taken at stated intervals.

Feelings and Attitudes: Changes in attitudes and feelings of subjects during the progress of the study were investigated by means of a questionnaire in terms of which responses of the subjects were obtained on pertinent questions.

Procedures in the Main Experiment

Administration of Tests: The main experiment consisted of 42 experimental sessions, each 5½ hours in length, held 6 days a week for a period of 7 weeks.

Pre-test Practice: In order to familiarize subjects with the experimental tasks and to provide an opportunity for concentrated learning prior to the initiation of the main experiment, a period of practice was introduced before the beginning of the experiment proper. The practice period consisted of 4 sessions, each 2 hours in length, during which each subject worked on all of the experimental tasks at a noise level of 72 db and with effective temperature conditions of 73, 73, 80 and 87 deg ET, respectively, on the four consecutive days. (See Table 1.)

Experimental Sessions: Experimental tasks were administered on the basis of carefully standardized procedures designed to equalize the influence of practice and of variations in output related to hour and day of work. The order of tests was

[2] *Plotting Room* conditions were given major consideration in the choice of atmospheric and noise conditions to be investigated.

Table 1—Order and Nature of the Experimental Periods (1940)

March 4	March 5-8	March 9	March 11-30	April 1	April 2-6	April 8-20	April 22-27	April 29	April 30 to May 5
Various tests administered in selection of subjects	Pre-Practice Periods Noise—69-74 db Effective Temperature as follows: Date / Deg ET 5 / 73 6 / 73 7 / 80 8 / 87	Speed, Trial Period 72 deg ET Noise—73 db	Series II Three Weeks of Experimental Work Periods Noise constant—72 db Effective Temperature systematically varied daily thus: Date / Deg ET 11 / 87 12 / 80 13 / 73 14 / 73 15 / 80 16 / 87 18 / 80 19 / 73 20 / 87 21 / 87 22 / 73 23 / 80 25 / 73 26 / 87 27 / 80 28 / 80 29 / 87 30 / 73	Speed, Trial Period 72 deg ET Noise—73 db	Intermission	Series III Two Weeks of Experimental Work Periods Group reduced from 8 to 6 subjects beginning with this Series. Two new subjects added to keep size of group constant but work of the two new members not averaged in with the original six. Effective Temperature and noise level varied daily systematically thus: Date / Deg ET / Noise Level db 8 / 73 / 80 9 / 87 / 90 10 / 80 / 80 11 / 80 / 90 12 / 87 / 80 13 / 73 / 90 15 / 73 / 90 16 / 87 / 80 17 / 80 / 90 18 / 80 / 80 19 / 87 / 90 20 / 73 / 80	Series IV Control Period One Week—same as third week of Series II	Speed Trial Period	Series V Six days of Experimental Work Periods Noise constant at 72 db Effective Temperature systematically varied daily, thus: Date / Deg ET 30 / 80 1 / 94 2 / 87 3 / 80 4 / 94 5 / 87* (*Unable to maintain temperature on this day)

varied for each subject from week to week, but during the course of the experimental series all subjects were given the same tests in the same order with approximately the same frequency. In addition, in the case of the pencil-and-paper tests, enough alternative test forms were provided so that no subject was given the same blanks on two successive days.[3]

The procedure for the experimental sessions was as follows:

1. Each subject reported to the laboratory 45 min before the experimental session and was provided with a standard lunch.

2. Each subject then spent 45 min at rest in an unconditioned anteroom with temperature at that prevailing in the building. The last few minutes of this 45-min period were spent in obtaining readings on pulse and oral temperature.

3. The subjects then entered the experimental room and immediately started working at the experimental tasks under temperature and noise conditions applying for the experimental session. Work on the experimental tasks in this portion of the experimental session was continued for a period of 2 hours.[4] At half-hour intervals during this work period each subject's pulse rate and oral temperature were taken by an experimenter without stoppage of work on the part of the subject. Pulse rate was taken at the temple, and temperature through insertion of a thermometer in the mouth of the subject. These measures were always taken within the last 5 min of the working spell.

4. Immediately upon the completion of this portion of the work session, subjects were allowed a 5-min rest period in the experimental room. During this time physiological measurements were repeated with the subject at rest.

5. Following the rest period subjects again spent 2 hours at work on the experimental tasks in accordance with the standard pattern. As in the first portion of the work period, pulse rate and oral temperature readings were taken at 30-min intervals.

6. At the end of the second work period subjects proceeded to the anteroom and spent a minimum of 30 min at rest before dismissal. Pulse rate and oral temperature readings were taken towards the close of this rest period.

Motivation of Subjects: Subjects were paid a base rate of 40 cents per hour for all time spent on the experiment, exclusive of lunch periods. In addition, bonus payments were made to subjects on both a group and individual basis to encourage maximum effort on the part of each subject throughout the experiment.

Attitude Questionnaire: One purpose of the study was to examine changes in attitude and feelings occurring under various conditions of noise and temperature. These problems were investigated by means of two questionnaires and in terms of a written statement by each subject. The first of these questionnaires referred to attitudes and feelings resulting from temperature conditions and was filled out by each subject at the close of the final session of Experimental Series II. The second questionnaire, dealing with reactions to noise conditions, was administered approximately one week after the completion of Experimental Series IV. Written statements were obtained from the subjects following their first work period at 94 deg ET in Experimental Series V.

Criterion Measures

Production Data: Accurate records were kept of production during successive five-minute intervals on each test by means of Veeder counters and electric timers in the case of the apparatus tasks, and by requiring subjects to indicate by check marks the amount of work completed in successive 5-min periods in the case of paper-and-pencil tests. From these records the following indices relating to production were computed:

1. *Output.* This measure referred to the total number of work units performed without respect to errors.

2. *Error Ratios.* This measure was computed for each individual on each

[3] With the exception of the Locations Test.

[4] One-minute intervals were allowed between 30-min work periods for changeover from task to task.

test (except the Discrimeter) by dividing total number of errors by total output including errors. Error scores on the Discrimeter were not available.

3. *Variation Percentages.* As indicated previously, records of output were obtained at 5-min intervals on all tests. Differences in output between successive 5-min periods of work on each test by each subject were averaged and then divided by the subject's average 5-min output on the task to obtain the variation percentage for the subject. This ratio gave an indication of fluctuation in output during successive 5-min intervals of the work period.

Physiological Measures

1. *Oral Temperature.* Oral temperature was taken in tenths of degrees Fahrenheit. Measurements for each subject were expressed in terms of increase or decrease in oral temperature during the period of work in the experimental room as compared with the oral temperature readings taken during the rest period immediately preceding the work period.

2. *Pulse Rate.* Pulse rates were recorded in terms of beats per min and were expressed as increase or decrease of pulse rate during the experimental period over that obtained during the rest period immediately preceding the work period.

Questionnaire on Feelings and Attitudes: No attempt was made to provide for quantitative treatment of data from these questionnaires.

Results

The data from this experiment were treated graphically, and the significance of differences between performances of the men under the several experimental conditions evaluated statistically by means of the *t* test.[5] Due to the limitations of space all of the graphs and tables cannot be presented in this report. However, the results of the complete analysis have been taken into consideration in the evaluation of the results which follow, and illustrative tables will be presented.

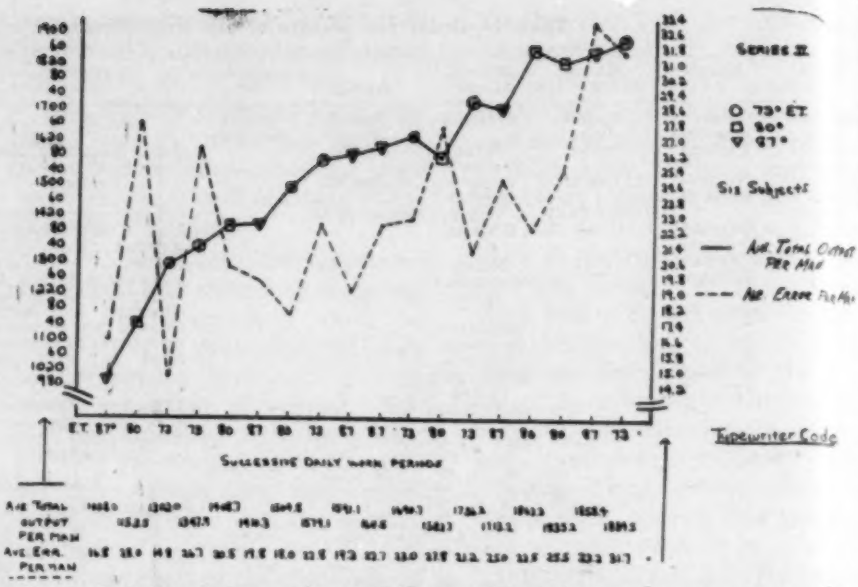


Fig. 1—Relation between time and the average output and error per man for Typewriter Code

Effect of Practice: In the case of every test improvement was demonstrated with increased practice. In other words, learning persisted throughout the entire experiment. This trend is evident, for example, in Fig. 1 in which are graphed the average total output per man, and the average errors per man in the various experimental sessions throughout the experiment in terms of the Typewriter Code Test. However, the influence of such learning so far as analysis of results is concerned is made constant by the fact that the average position and deviation (in rank) of experimental trials is identical for each of the temperature conditions, 73, 80 and 87 deg, respectively, and for each of the noise levels, 72, 80, and 90 db, respectively.

Effect of Changes in Effective Atmospheric Conditions

Output: Output on the varied tasks used in this investigation is not adversely affected by a change from 73 to 80 deg ET. As a matter of fact, maximum output is obtained as frequently at 80 deg ET as at 73 deg ET. The differences in performance on individual tasks when these two effective temperatures are compared are small in extent and are statistically insignificant in every instance. This is evidenced by reference to Table 2 in which the output data are summarized from experiments in Series II, where effective temperature was varied with the noise level held constant at 72 decibels.

However, at an 87 deg ET output is consistently lower than at 73, and 80 deg ET, respectively. As is indicated by Table 2, the reduction in output ranges from 2.7 to 13.9 per cent of maximum output, but only in two cases (Lathe Test and Number Checking) is the reduction as great as 5 per cent. Differences between output at an 87 deg ET and at the lower effective temperatures are found to be statistically significant at the 5 per cent level or lower in the case of four tests, namely: Mental Multiplication, Number Checking, Lathe, and Pursuit Test.

Accuracy: Except in the case of the Lathe Test the percentage of errors in response remains practi-

Table 2—Group Total Performance Output at Various Effective Temperature Levels
Series II
(Six Subjects Who Finished All Series)

Performance	Group Output (%)			Significance of Differences (P)		
	73 ET	80 ET	87 ET	73 - 87 ET	80 - 87 ET	73 - 80 ET
Mental Mult.	100.0	99.1	96.7	0.01-0.02	0.02-0.05	0.40-0.50
No. Checking	100.0	99.6	95.0	0.02-0.05	0.02-0.05	0.70-0.80
Lathe	98.5	100.0	86.1	0.02-0.05	0.01-0.02	0.20-0.30
Type. Code	100.0	98.1	96.5	0.20-0.30	0.40-0.50	0.20-0.30
Discrimeter	100.0	98.0	97.3	0.20-0.30	0.70-0.80	0.20-0.30
Locations	99.0	100.0	97.2	0.10-0.20	0.05-0.10	0.30-0.40
Pursuit	98.1	100.0	96.5	0.10-0.20	0.01-0.02	0.05-0.10

[5]The significance of observed differences has been statistically determined with use of the following formula for the standard error of the difference between means in terms of differences between paired scores:

$$\sigma(m_x - m_y) = \frac{\sigma(x-y)}{\sqrt{N-1}}$$

In each case, Fisher's technique for use in treatment of small group data has been applied in interpreting the relationship between the difference between means and the standard error of that difference. This technique provides a *P*-value which indicates the probability that an observed difference in two performances is due to chance. A *P*-value of 0.01 means that the probability that an observed difference is due to chance is only 1 in 100. Where the *P*-value is between 0.02 and 0.05 the probability is from 2 to 5 in 100 that the observed difference between means is due to chance. *P*-values of 0.05 and under are generally regarded as significant, values of 0.01 as very significant. . . . . R. A. Fisher, *Statistical Methods for Research Workers*, 5th Ed., Edinburgh, Oliver and Boyd, 1934, p. 118.

Table 3—Total Performance Output at Various Noise Levels
Series II (last week) III & IV
(*Six Subjects*)

Performance	Group Output (%)			Significance of Differences (P)		
	72 db	80 db	90db	72 - 90 db	80 - 90 db	72 - 80 db
Mental Mult.	94.8	96.5	100.0	0.01	0.01-0.02	0.30-0.40
No. Checking	94.1	98.9	100.0	0.02-0.05	0.20-0.30	0.05-0.10
Lathe	106.0	97.4	97.6	0.40-0.50	0.90-1.00	0.20-0.30
Type. Code	97.9	100.0	99.7	0.40-0.50	0.80-0.90	0.30-0.40
Discrimeter	100.0	95.6	97.3	0.20-0.30	0.50-0.60	0.05-0.10
Locations	99.8	99.0	100.0	0.70-0.80	0.50-0.60	0.60-0.70
Pursuit	97.8	98.7	100.0	0.30-0.40	0.20-0.30	0.60-0.70

ally unchanged with variations in the range of 73 to 87 deg ET. Even in the case of the Lathe Test the absolute increment in error ratio is not great. Moreover, neither in the case of the Lathe Test, nor of any other test, were changes in accuracy accompanying changes in temperature statistically significant.

Variability of Performance: Analysis of the variation percentages indicated that performance at an 87 deg ET tended to be more variable than performance at the lower effective temperatures. In other words, there was a tendency for greater fluctuation in the amount of work done in successive 5-min periods at 87 deg ET than at 73 and 80 deg ET, respectively. However, the amount of absolute difference is not great in the case of any of the tasks employed and is statistically significant only in the case of the Number Checking and Discrimeter Tests.

Physiological Measures: In addition to the production measures, it is necessary to consider the effect of the experimental temperature conditions on physiological changes. The data indicated that there was a consistent increase in both pulse rate and oral temperatures with increase in effective temperature from 73 deg through 80 to 87 deg, and that the differences in both pulse rate and oral temperature from 73 deg through 80 to 87 deg, respectively, are statistically significant. The amount of increase in pulse rate and oral temperature (over readings during rest) is most marked at the 87 deg level, the average increase at that level being approximately 1½ F for oral temperature, and approximately 20 beats per minute for pulse rate.

General Conclusions with Respect to Changes in Effective Temperature: On the basis of these findings it may be safely said that for work periods not exceeding 4 hours on tasks of the type employed in this investigation no adverse effects on performance are produced by an increase from 73 to 80 deg ET. With an increase to 87 deg appear indications of adverse effects upon quantity and variability of performance. While these are not marked, the indications from the main experiment, combined with those of the supplementary experiment (Series V) described below, suggest that as effective temperature is increased to 87 deg, there is an approach to a *danger zone* so far as the effect of temperature on performance is concerned.

The Effect of Changes in Noise Conditions

Output: Analysis of the data indicated that increase in noise level above 72 db, considered apart from the effect of temperature, appears to be somewhat favorable to increased output.[6] This is evident, for example, from examination of Table 3. The effect is most marked at the 90 db level which furnishes maximum output in the case of 4 of the 7 tasks, including all of the paper and pencil tests involving a minimum of physical movement and a maximum of intellectual activity. Output is highest at the 72 db level only in the case of two tasks (Lathe Test and Discrimeter). However, the amount of superiority of output at the 90 db level is in no instance great and the difference between output at this level of noise and at that level which gives minimum output is statistically significant at the 5 per cent level or lower only in the case of Mental Multiplication and Number Checking tasks. In the latter case a statistically significant difference is evident only in the comparison of performance at 72 and 90 db, respectively.

Accuracy: Accuracy was not consistently or seriously affected by increase in the amount of noise from 72 to 90 db. In the case of two tasks, Mental Multiplication and Lathe, there was a statistically significant adverse effect upon accuracy with increase of noise to 90 db, but even in the case of these tests the total loss of accuracy is relatively negligible, the error ratios under the 80 and 90 db conditions being 2.98 and 3.23, respectively, in the case of the Mental Multiplication, and 16.54 and 17.23, respectively, in the case of the Lathe Test. The Locations Test actually shows a statistically significant decrement in error ratio at the 90 db level.

Variability of Performance: Variability of performance is not affected markedly by changes in the amount of noise. On some tasks the variability of performance increases slightly with increasing noise, on other tasks the variability of performance decreases slightly with decreasing noise. Only in the case of the Pursuit Test was there a statistically significant increase in variability with increase in noise, the total amount of change again being negligible, the variation percentage increasing from 12.39 to 14.31 in this case.

Physiological Measures: Examination of the data indicated no marked changes in terms of pulse rate and oral temperature associated with changes in noise level. In only four cases were differences statistically significant at the 5 per cent level or lower. Three of these arose in comparisons of oral temperature at the 72 and 80 db levels.

General Conclusions with Respect to Changes in Noise Levels: The findings of this experiment support the conclusion that performance on tasks such as those used in this experiment is not adversely affected by a rise in noise level to 90 db. On the basis of psychological data alone it would seem that expenditure of funds for the reduction of noise as a means of improving quality of performance during a 4-hour period of work at the type of tasks involved in this investigation is not warranted.

[6] It is interesting to note that these results on increased output with increasing noise are in conformity with other experiments of the same kind. However, these other experiments also show an increase in energy output in noisy as compared with less noisy conditions.

Effect of Combined Changes in Atmospheric and Noise Conditions: Production under stated combinations of noise and atmospheric conditions is presented in Table 4. Examination of this table indicates that in the case of every task but the Discrimeter, the lowest output occurred with conditions at the 87 deg ET level, the lowest output for the latter task occurring at the 80 deg ET. Even in this case this level of output is very little below that obtained at the 87 deg level with noise at 72 db. A similar tendency is observable with respect to errors. On the other hand, when atmospheric and noise conditions are considered in combination there is no consistent tendency for lowest output to be associated with any one of the three noise levels. Actually, in two tasks lowest output occurs at the 72 db level, in two other tasks at the 80 db level, and in the case of the remaining three tasks at the 90 db level.

Results of Supplementary Experiment (Series V). As noted previously in this experiment it was planned to compare the influences of 80, 87 and 94 deg ET, respectively, with noise held constant at 72 db. It was originally planned to obtain two days of experimental readings under each temperature condition with each subject. Because of interruption in heating service, it was possible to obtain only one experimental day of readings with an effective temperature of 87 deg.

Because of this fact, and since none of the subjects were able to complete the tasks upon their first exposure to a 94 deg ET, the volume of data was insufficient for the formulation of specific conclusions regarding performance under this condition. However, it is significant to note that none of the subjects were able to complete their first four hour period at 94 deg ET and all of them reported physiological effects such as dizziness, partial or complete visual blackout, and nausea at this effective temperature. There was one case of nose-bleed and some staggering or swaying on the part of almost all of the subjects. There were marked increases in both oral temperature and pulse rate. At 94 deg ET the average increase in oral temperature was approximately 2½ F, and the average increase in pulse rate approximately 45 beats per minute.

Under the 94 deg ET conditions output was considerably reduced and error scores considerably increased for most of the tests. The reduction in output as compared with that under an 80 deg ET varied from 14 to 42.6 per cent for the various tasks. Increase in variability also was noted. The results of this supplementary experiment again suggest that there is an approach to a *danger zone* as temperature is increased to 87 deg and that an increase to 94 deg is definitely and highly detrimental to performance. It is apparent that further investigations should concern themselves with the influence of effective temperatures between approximately 80 deg and 90 deg.

Table 4—Total Performance Output and Ratios of Errors to Total Performance Output Under Various Combined Effective Temperature-Noise Level Conditions[a]
Series II (last week) III & IV
(Six Subjects)

Deg ET	72db	80 db	90 db
Mental Mult.			
73	89.5 (2.86)	88.6 (3.18)	96.8 (3.20)
80	90.9 (2.70)	100.0 (2.65)	94.2 (3.38)
87	91.4 (2.90)	88.2 (3.11)	95.7 (3.20)
No. Check			
73	89.1 (2.78)	92.0 (2.78)	100.0 (3.22)
80	90.3 (3.19)	95.0 (2.60)	97.7 (3.41)
87	88.2 (2.86)	90.8 (3.79)	90.7 (3.21)
Lathe			
73	100.0 (10.3)	94.9 (16.3)	95.2 (15.1)
80	95.8 (12.8)	91.5 (15.7)	98.2 (16.2)
87	84.4 (12.7)	86.4 (16.3)	80.0 (19.4)
Type. Code			
73	95.4 (1.97)	99.3 (2.09)	98.8 (1.81)
80	97.2 (2.04)	99.8 (2.26)	100.0 (2.31)
87	95.3 (2.05)	94.8 (2.22)	94.3 (2.07)
Discrimeter			
73	100.0	93.9	89.2
80	95.9	86.4	97.2
87	87.1	90.4	89.1
Locations			
73	96.2 (1.06)	96.7 (1.18)	94.7 (1.09)
80	96.9 (1.15)	93.8 (1.18)	100.0 (1.08)
87	93.5 (1.32)	93.9 (1.28)	92.6 (0.95)
Pursuit			
73	95.8 (0.85)	94.7 (0.82)	97.4 (0.84)
80	97.6 (0.78)	94.4 (0.82)	100.0 (0.65)
87	92.7 (0.93)	97.3 (0.89)	95.1 (0.99)

[a]Total output is expressed as a percentage of the maximum appearing under any of the conditions. Error ratios appear in parentheses.

Changes in Feelings and Attitudes Associated with Various Noise Levels and Temperature Conditions: The principal source of data on feelings and attitudes of the subjects during the experiment was a questionnaire presented to the subjects at the close of the main and of the supplementary experiment respectively. It was not possible to treat these data quantitatively. However, following is a summary of the major findings obtained from an inspection of questionnaire data:

1. Subjects were not able to identify with any degree of accuracy the nature or range of variations of both temperature and noise employed in this experiment.

2. Under conditions of 94 deg ET subjects definitely report increased discomfort and feelings of annoyance and distress.

3. There is no indication of marked discomfort or annoyance and distress at 73 deg or 80 deg ET. At 87 deg ET all of the subjects reported unfavorable reactions such as feelings of discomfort, sluggishness, irritability, and fatigue.

4. The reports on the noise questionnaire indicated a very rapid adjustment to increased noise with no indication that even a noise level of 90 db exercises a seriously disturbing influence on attitude of subjects under the conditions of this investigation.

Summary and Conclusions

The following tentative conclusions may be drawn from a consideration of the results:

1. The findings suggest that there is no need to provide equipment for the reduction of effective temperatures below the 80 deg level where tasks of the type included in this investigation are to be performed. There is some evidence that it may be undesirable to do this type of work at effective temperatures as high as 87 deg but further investigation, within this range of approximately 87 deg to 94 deg is required to determine more exactly the critical level of temperature.

2. The evidence suggests that it is unnecessary to undertake considerable expenditure of funds to reduce the noise involved in the cooling and circulation of air, at least if such noise does not rise above the 90 db level. In general it would appear that the effect of high temperature on performance is much more adverse than that of high level of noises of the type reproduced in this experiment.

Alfred J. Offner
New York, N. Y.
President

Proceedings of the 52nd Annual Meeting

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Commodore Hotel, New York City
January 28-30, 1946

(Concluded from February Journal)

First Session—Monday, January 28, 2 P.M.

Pres. C.-E. A. Winslow, New Haven, Conn., declared the 52nd Annual Meeting of the Society formally opened on Monday, January 28, in the West Ballroom of the Commodore Hotel, and introduced H. J. Ryan, New York, N. Y., president of New York Chapter, who welcomed the members and guests to the first post-war meeting. In thanking Mr. Ryan for the cordial welcome, Dr. Winslow spoke of the able manner in which the New York Chapter Committee on Arrangements had prepared for the meeting.

President Winslow, in giving his report as president, referred to the reports of the Council and Council Committees, which were to be presented, and reviewed the activities of the Society for the past year.

The Society membership, he said, had increased from 3854 to 4504 during 1945 as shown in the following tabulation:

STATUS OF MEMBERSHIP AS OF JANUARY 1, 1946

Charter Members	2	
Honorary Members	2	
Life Members	112	
Members	2,380	
Associates	1,767	
Juniors	216	
Students	25	
Total	4,504	
Elections and Reinstatements		735
Resignations, Cancellations and Deaths		85
Net gain for year 1945		650
Membership as of January 1, 1945		3,854
Net gain		650
Membership as of January 1, 1946		4,504

A goal of 5000 was suggested to the chairman of the incoming Membership Committee.

The Committee on Admission and Advancement had considered applications of over 700 and found it expedient to hold several meetings during the past year instead of following the former procedure of conducting its work by mail.

The Society has 37 chapters and all but three of the chapters had been visited by officers during the past year and numerous speakers had been provided by the Society's Chapter Relations Committee. Dr. Winslow said that he had been impressed by the vitality of the chapters and by an apparent realization of chapter responsibility, which was due partly to the effect of the news letter which had been sent out by G. D. Winans, Detroit, Mich., chairman of the Chapter Relations Committee.

While the place of the summer meeting had not been finally agreed upon, it was possible to announce that the 53rd Annual Meeting will be held in Cleveland, O., and that the 7th Heating, Ventilating and Air Conditioning Exposition will be held simultaneously and thereafter the exposition would probably be an annual event.

A special committee on Housing Society Offices and Laboratory, under Chairman E. N. McDonnell, Chicago, Ill., in cooperation with the Executive and Finance Committees investigated 22 possible sites for the Laboratory in Cleveland and considered locations in other cities. When it became apparent that no satisfactory lease could be arranged, plans were approved to purchase a property at 7219 Euclid Ave., Cleveland, which will be available by the end of March when the lease on the present laboratory expires. The new property consists of a large frame house with a two-story brick auditorium in back and appears to be ideally suited for laboratory purposes. By this purchase of the building, it is now possible to go forward with the enlarged research program. If another permanent home should be sought, plans for it could proceed whenever the Society desired, rather than because it was necessary to move as in the past. Great credit for the progress made was due to Chairman McDonnell for his tireless devotion to the task.

Under the direction of Prof. G. L. Tuve, chairman of the Committee on Research, and the able leadership of Cyril Tasker, Director of Research, the Laboratory was able to report nine laboratory projects under way in Cleveland and

15 projects begun by cooperative research contracts with 10 different universities. Twenty technical advisory committees had been appointed. The U. S. Public Health Service delegated Dr. A. D. Brandt, a specialist on industrial hygiene, to work at the ASHVE Research Laboratory. This arrangement promised to be of great importance to the Society in effecting a correlation of the work on industrial hygiene with medical and engineering knowledge in this field. (The complete report of the Committee on Research was published in the ASHVE JOURNAL SECTION, Heating, Piping & Air Conditioning, February, 1946.)

The financial position of the Society was excellent and Treas. L. P. Saunders, Lockport, N. Y., as well as Dr. B. M. Woods, Berkeley, Calif., chairman of the Finance Committee, deserves much credit for their work.

Financing of the research work had received much attention. The funds available for research, obtained from a portion of the dues, proceeds from expositions, from THE GUIDE, and from gifts solicited from industry by means of letters, amounted to $40,000 to $50,000 a year. A minimum budget for Society research should be well over $100,000 and the Council had therefore developed a program by which this amount could be obtained. A special committee under the chairmanship of Dr. A. C. Willard, President of the University of Illinois, Urbana, had made plans for obtaining funds from industry to participate in the Society's research program.

As in the past, the Laboratory will not undertake commercial work or testing of materials, but will devote its research work to problems of basic interest to all. To aid in fund raising the committee is now satisfied that it has found a qualified man who is familiar with research, who has been connected with the research program of the Society, and who also has the ability to interpret this knowledge to executives of industry.

THE GUIDE had been greatly revised and 100 pages had been added to the technical text although this addition had reduced somewhat the number of copies which could be printed from the paper stock available. C. S. Leopold, Philadelphia, Pa., chairman, and the members of the Guide Publication Committee, had done a splendid job. A major revision in THE GUIDE had been made in the rearrangement of chapters, but this change had been made carefully, thoughtfully and usefully.

The reports of the Council, Secretary, Treasurer and Accountant to which President Winslow referred follow:

Report of Council

The business affairs of the Society were handled by the Council, which held four meetings, January 24 in Boston, May 14 in Chicago, October 7, 1945, in Cleveland, and January 27, 1946, in New York City.

At the organization meeting in Boston the Council approved the appointment of committees suggested by President Winslow, and confirmed the appointment of the Secretary and Technical Secretary, selected depositories for Society funds, and selected a certified public accountant.

The Council agreed to sponsor the organization of the Joint Committee on Psychrometric Data and voted to increase the personnel of the Guide Publication Committee because of the heavier volume of work required. It was voted that the customary summer meeting would not be held.

Immediately following the Annual Meeting the Society suffered an unexpected loss in the death of Commander F. C. Houghten, former Director of the Society's Research Laboratory and again in May the Society lost its Second Vice-President, W. A. Russell, Kansas City. Since that time it has also suffered the loss of three past presidents, Thornton Lewis, D. S. Boyden and C. B. J. Snyder, and very recently a former Treasurer of the Society, F. D. Mensing. Appropriate resolutions have been drafted on behalf of the Council and Officers.

The five Council Committees have been exceedingly active this year and several special Council Committees were appointed, one to solve the problem of Research Fund Raising, another the Housing of Society Offices and Laboratory, and third, History of the Society.

The officers have visited nearly all of the Chapters of the Society during the past year. The Committee on Constitution and By-Laws has been very active in having a new Charter prepared and in drafting several By-Law Changes which are being submitted to the Society.

The Meetings Committee has prepared a program for the Annual Meeting. At the October Meeting a decision was reached to hold the 7th Heating and Ventilating Exposition in January 1947, in connection with the 53rd Annual Meeting of the Society, and annually thereafter as long as desirable.

The Budget for the fiscal period November 1, 1945 to October 31, 1946 was adopted providing for an estimated income of $117,285.00 and expenditure of $115,405.00.

The award of the F. Paul Anderson Medal was authorized and arrangements were made for its presentation at the 52nd Annual Meeting.

Respectfully submitted,

THE COUNCIL

Report of Secretary

In the 12-month period between the 51st Annual Meeting in Boston and the 52nd Annual Meeting in New York there have been many problems for the Secretary's office to meet. One of the most vital was the matter of personnel which was only partially solved. This accounts for some of the delay in acknowledging receipt of dues and the preparation of Transactions.

With an increase in membership of over 700 the slogan of the Membership Committee of 4500 in '45 became a reality. The Admission and Advancement Committee held frequent meetings both in New York and elsewhere to do its work which was exceeded in volume only once before in Society history. New membership literature has been prepared and is being sent to the list of prospects compiled by Chapter Membership Committees.

An important new duty was to handle the details of the assignment of speakers to Chapters under the auspices of the Chapter Relations Committee. The trips to Chapters for the Officers were arranged.

Assistance has been given to many members who desired new connections after leaving the service. There are still 316 in service, the top figure being 427 earlier this year.

Publication matters have taken a great many hours in preparing the monthly Journal, completion and production of THE GUIDE, membership list and Transactions. It is pleasant to report that the 50th Anniversary edition of the Transactions went into the mail early in January and THE GUIDE 1946 is on the press and will be ready for distribution in March.

Members will find a much larger text and more firms represented in the catalog data section this year.

Editions had to be held to a minimum as there were difficulties experienced in obtaining paper and the quality is not up to previous standards. Costs increased greatly and a new selling price for THE GUIDE will be effective this year.

An increase in the advertising rates has been authorized effective next year because of the wider distribution of THE GUIDE and its increase in size.

The Society now has 37 chapters and it is anticipated that one or more will be chartered soon. Activity in the Norfolk area indicates the organization of an Old Dominion Chapter this year.

All of the routine actions required by the Constitution and By-Laws have been taken with regard to membership, finances, publications and other activities and the reports of the various committees will indicate the extent of the work accomplished.

During this year the Society has suffered great losses in the deaths of its Vice President W. A. Russell, three of its past presidents, Thornton Lewis, D. S. Boyden, C. B. J. Snyder, a former treasurer, F. D. Mensing, its Research Laboratory Director Commander Ferry C. Houghten and 20 other members.

The known war toll has been five members out of over 400 members in service.

Correspondence is now opening up with a great many of our foreign members who have been isolated from the U.S. during the war.

It is indeed a pleasure for me to tell you that the many activities of the Society could not have been carried on without the full cooperation and loyalty of the staff.

This year was one of the most successful in the history of the Society and all who have participated, the Officers, Council, Committees, and Chapter Officers can find satisfaction in the prediction made at the 50th Annual Meeting, that the Society was looking forward to a greater future.

Respectfully submitted,
A. V. HUTCHINSON, *Secretary.*

Accountant's Report

Tusa & La Bella
Certified Public Accountants
52 **William Street**
New York

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS,
51 Madison Avenue,
New York, N. Y.

Gentlemen:

Pursuant to your request, we examined the books of account and records of the American Society of Heating and Ventilating Engineers—New York, N. Y., and the related funds for the fiscal year ended October 31, 1945, and submit herewith our report.

The audit covered a verification of the Assets and Liabilities as of the close of business October 31, 1945. Also, for the fiscal year then ended, we traced the recorded cash receipts into the depositories; we inspected the cancelled bank checks which we compared with the record of cash disbursements; we supported the disbursements by payment vouchers; we accounted for the dues income and interest income from savings accounts and securities.

A Balance Sheet reflecting the financial condition of the Society as of the close of business, October 31, 1945 is submitted herewith and your attention is directed to the following comments thereon:

CASH

The Cash on Deposit was verified by direct communication with the commercial and savings banks listed in the schedule of cash included in this report and reconcilement of the amounts reported to us with the respective balances reflected by the books of the Society.

Checks representing the Cash on Hand for Deposit were inspected by us and the Petty Cash counted.

MARKETABLE SECURITIES

The securities, shown on the subjoined schedule, were verified by direct communication with the Bankers Trust Company, where same are deposited for safe-keeping. This Asset has been included in the Balance Sheet at the cost of acquisition plus the accumulated and accrued interest earned thereon.

CERTIFICATE OF INDEBTEDNESS

The Certificate of indebtedness issued to the Society was verified by inspection of the instrument.

The installments and interest on this indebtedness are being paid as due.

ACCOUNTS RECEIVABLE

A trial balance of the membership dues receivable taken as of the close of business October 31, 1945 was classified as to membership and aged as follows:

CLASSIFICATION	AMOUNT
Members	$2,189.00
Associates	1,558.00
Juniors	173.50
Students	3.00
TOTAL	$3,923.50

AGING	AMOUNT
Dues Invoiced during 1945	$3,282.50
Dues Invoiced during 1944	156.50
Dues Invoiced prior years	384.50
TOTAL	$3,923.50

The miscellaneous accounts receivable also were classified and aged as follows:

CLASSIFICATION	AMOUNT
Guides (Advertising, Copy Sales)	$1,147.45
Transactions	66.50
Books and Reprints	129.54
Emblems	7.10
Sundry	52.13
TOTAL	$1,402.72

AGING	AMOUNT
Charges made during October, 1945	205.19
Charges made during September	166.25
Charges made during August, 1945	44.41
Charges made Prior	986.87
TOTAL	$1,402.72

The Reserve for doubtful Dues and Miscellaneous accounts receivable, in our opinion, are ample to cover probable losses that might result during realization.

INVENTORIES

The emblems and transactions on hand on October 31, 1945 were counted by us. The guide paper was verified by direct communication with the printers. All inventories were priced and computed by us. The transactions follow:

Volume Prior	Year Prior	Quantity	Price	Amount
45	1939	111	1.66	184.26
46	1940	50	1.25	62.50
47	1941	19	1.32	25.08
47	1941	150 (unbound)	.96	144.00
48	1942	52	1.42	73.84
49	1943	307	1.39	426.73
			TOTAL	$ 2,266.41

PERMANENT ASSETS

Furniture, Fixtures and Library are shown herein at the book values without appraisal by us, we did, however, provide for depreciation of furniture and fixtures at the rate of ten percent per annum.

DEFERRED CHARGES

We have deferred to future income one-sixth of all the subscriptions paid to H.P.A.C. since the payment of same are on a calendar year basis and the fiscal year of the Society ends on October 31st.

ACCOUNTS PAYABLE

All purchase invoices found on the file that were applicable to the operations of the current fiscal period were listed and the proper liability therefor reflected in the attached balance sheet.

TAXES WITHHELD

The sum of $497.30 represents Federal Income taxes withheld from salaries paid to employees during the month of October, 1945.

DEFERRED INCOME

On October 31, 1945, the prepaid dues by elected members were:

Members	$243.46
Associates	322.84
Juniors	63.50
TOTAL	$629.80

In addition there were dues in the sum of $395.00 prepaid by members proposed for membership.

RESERVE FOR PUBLICATIONS

In accordance with provisions made both in the 1944 and 1945 budgets, we have reserved the sums of $3,500.00 and $4,500.00, respectively, to cover the publication of transaction volumes 50 and 51.

FUNDS

An analysis of the following funds reflecting the changes that occurred in these accounts during the fiscal year ended October 31, 1945, is included herein:

General Fund
Reserve Fund
Endowment Fund
Permanent Building Fund
F. Paul Anderson Fund

On October 16, 1944, the council adopted the following resolutions:

"That in accordance with **Article B-XI**, *Section 8* of the By-Laws, that the reserve fund shall be increased to an amount equivalent to $15.00 per member as of October 31, 1944, by transfer of money in the General Fund to the Reserve Fund."

"That the amount of Initiation Fees in excess of the sum required to meet the requirements of the By-Laws for the reserve fund as of October 31, 1944, be allocated to the Permanent Building Fund."

We have allocated all the initiation fees collected during the current fiscal year to the Reserve Fund, since the membership at $15.00 per member totaled $65,910.00 and exceeds the Reserve Fund of $64,493.66 on October 31, 1945. For this reason no allocation of initiation fees was made to the Permanent Building Fund.

There is submitted herewith a complete financial report as prepared for the Committee on Research setting forth the financial condition of the Research Fund as of the close of business on October 31, 1945, and the results from operations for the fiscal year then ended.

INCOME AND EXPENSES

A statement in summary form reflecting the Income and Expenses and comparable items budgeted for the fiscal year ended October 31, 1945, of the Society, Guide and Research follows:

SOCIETY	Actual	Budgeted
Income	$67,604.84	$61,785.00
Expenses	67,115.72	63,905.00
NET INCOME OR OUT-GO	489.12	2,120.00
GUIDE		
Income	61,242.22	54,000.00
Expenses	42,764.19	37,800.00
NET INCOME	18,478.03	16,200.00

RESEARCH		
Income	54,062.94	$6,800.00
Expenses	51,676.76	76,550.00
NET INCOME OR OUT-GO	2,386.18	10,250.00
TOTAL NET INCOME	$21,353.33	$24,330.00
CAPITAL ITEMS		
New Equipment for Research	$ 5,862.42	$10,000.00
Initiation Fees to Reserve Fund	$ 7,091.00	$ 3,700.00

Respectfully submitted,
Tusa & La Bella,
Certified Public Accountants.

Dated December 14, 1945.

BALANCE SHEET

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS—NEW YORK, N. Y.

October 31, 1945

ASSETS

GENERAL FUND				
CASH				
On Deposit		$33,690.13		
On Hand		100.00	$33,790.13	
INVESTMENTS (AT COST)				
Securities (Market Value $23,665.00)		22,900.00		
ADD: Accumulated Interest	$ 1,290.00			
ADD: Accrued Interest	105.00	1,395.00	24,295.00	
CERTIFICATE OF INDEBTEDNESS			75.52	
ACCOUNTS RECEIVABLE				
Membership Dues		3,923.50		
LESS: 40% for Research	2,110.33			
LESS: Reserve for Doubtful	290.63	2,400.96		
		1,522.54		
Advertisers and Sundry Debtors	1,402.72			
LESS: Reserve for Doubtful	112.50	1,290.22	2,812.76	
INVENTORIES				
TRANSACTIONS		2,266.41		
Emblems		425.41		
Guide Paper		2,394.49	5,086.31	
EXCHANGE			61.00	
PREPAID TRAVELING			67.44	
PERMANENT				
Library		300.00		
Furniture and Fixtures	3,248.44			
LESS: Reserve for Depreciation	2,067.25	1,181.19	1,481.19	
DEFERRED CHARGES				
Prepaid H.P.A.C. Subscriptions			1,320.28	$68,989.63
RESERVE FUND				
Cash on Deposit		3,921.10		
Cash on Hand for Deposit		7,181.00	11,102.10	
Securities at Cost (Market Value $53,394.75)		50,719.06		
ADD: Accumulated Interest	2,638.75			
ADD: Accrued Interest	33.75	2,672.50	53,391.56	64,493.66
ENDOWMENT FUND				
Cash on Deposit		2,660.51		
Cash on Hand for Deposit		212.50	2,873.01	
Securities at Cost (Market Value $23,781.45)		22,005.65		
ADD: Accumulated Interest	1,195.85			
ADD: Accrued Interest	54.69	1,250.54	23,256.19	26,129.20
F. PAUL ANDERSON FUND				
Cash on Deposit		8.98		
Cash on Hand for Deposit		12.50	21.48	
Securities at Cost (Market Value $988.00)		1,000.00		
ADD: Accrued Interest		12.50	1,012.50	1,033.98
PERMANENT BUILDING FUND				
Cash on Deposit		5,889.23		
Cash on Hand for Deposit		684.92	6,574.15	
Due from Reserve Fund			1,551.61	8,125.76
				$168,772.23

LIABILITIES AND FUNDS

GENERAL FUND				
LIABILITIES				
ACCOUNTS PAYABLE			$ 886.05	
FEDERAL WITHHOLDING TAXES			497.30	
ACCRUED ACCOUNTS				
Additional Compensation to Employees			4,449.14	
DEFERRED INCOME				
Prepaid Membership Dues	$ 629.80			
LESS: 40% Prepaid to Research	226.52	$ 403.28		
Dues Prepaid by Candidates for Membership		395.00		
Fees Prepaid by Servicemen		68.50	866.78	
RESERVE FOR PUBLICATIONS				
Transactions (1944), Volume 50			3,431.89	
Transactions (1945), Volume 51			4,500.00	
TOTAL Liabilities			14,631.16	
GENERAL FUND			54,358.47	$68,989.63

NOTE "A"—This Balance Sheet is subject to the comments contained in the letter attached to and forming a part of this report.

RESERVE FUND			
Due to Permanent Building Fund		$ 1,551.61	
Principal	$61,946.00		
Unexpended Income	996.05	62,942.05	64,493.66
ENDOWMENT FUND			
Principal		25,378.40	
Unexpended Income		750.80	26,129.20
F. PAUL ANDERSON FUND			
Principal		1,021.48	
Unexpended Income		12.50	1,033.98
PERMANENT BUILDING FUND			
Principal		8,036.86	
Unexpended Income		88.90	8,125.76
			$168,772.23

STATEMENT OF INCOME AND EXPENSES

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS—NEW YORK, N. Y.

For the Fiscal Year Ended October 31, 1945

INCOME

INCOME FROM MEMBERS				
DUES—RENEWALS				
Members and Associates	$56,177.65			
LESS: Cancellations	458.50	$55,719.15		
LESS: 40% to Research Fund		22,287.66	$33,431.49	
Junior and Students		1,355.50		
LESS: Cancellations		16.50	1,339.00	$34,770.49
DUES—NEW MEMBERS				
Members and Associates		7,425.00		
LESS: 40% to Research Fund		2,970.00	4,455.00	
Junior and Students			365.50	4,820.50
TOTAL DUES				39,590.99
OTHER INCOME				
Initiation Fees			7,091.00	
Emblems and Certificate Frames			786.52	7,877.52
TOTAL INCOME FROM MEMBERS				47,468.51
INCOME FROM PUBLICATIONS				
Editorial Contract			17,249.96	
Guide Sales and Advertisements—Per Schedule Attached			60,797.22	
Sale of Transactions			1,560.63	
Income from Books, Reprints, Etc.			188.82	
Servicemen's Fees			1,014.50	80,811.13
INCOME FROM INVESTMENTS				
Interest—Savings Accounts			85.60	
Interest—Securities			480.00	
Interest—Certificate Frames			1.82	567.42
TOTAL INCOME				$128,847.06

EXPENSES

OPERATING EXPENSES		
President's Fund	$ 1,462.89	
Council Travel and Meetings	1,348.40	
Membership Committee	1,063.50	
Admissions and Advancement Committee	421.48	
Constitution and By-Laws Committee	207.11	
Nominating Committee	24.94	
Cardex Books to Chapters	154.76	

OPERATING EXPENSES—*(Continued)*			
Chapter Relations Committee and Records	229.85		
Executive Committee Allowance	13.43		
Finance Committee	24.27		
Chapter Delegates Travel	3,745.26		
A. S. A. Membership	100.00		
Membership Certificates	1,069.49		
Medals and Awards	70.00	$ 9,935.38	
MEETING EXPENSES			
Meetings	1,273.27		
Speakers to Chapters	1,253.99		
Chapter Meeting Allowance	650.00	3,177.26	
PUBLICATION EXPENSES			
Members' Subscriptions, H.P.A.C.	7,667.07		
Guide Publication and Distribution—Per Schedule Attached	42,764.19		
Transactions	5,190.04		
Membership Roll	738.30		
Standards (Including Codes)	5.46		
Publication Committee Expense	97.55	56,462.61	
HEADQUARTER'S EXPENSE			
Salaries—Secretary and Staff	25,762.48		
Additional Compensation	4,449.14		
Traveling—Secretary and Staff	1,030.47		
Rent and Light	3,803.82		
Telephone	998.58		
Telegraph	333.10		
Postage	2,642.10		
General Printing	650.71		
Office Supplies	894.55		
Addressing and Address Changes	221.79		
Professional Services	950.00		
Bank Charges	82.21		
Depreciation of Furniture and Fixtures	324.84		
General Office Expense	1,148.58		
TOTAL HEADQUARTER'S EXPENSE	43,292.37		
LESS: 30% APPLICABLE TO GUIDE	12,987.71	30,304.66	99,879.91
NET INCOME			28,967.15
DEDUCT COUNCIL APPROPRIATIONS			
Initiation Fees to Reserve Fund		7,091.00	
Special Appropriation to Research		10,000.00	17,091.00
EXCESS OF INCOME OVER EXPENSES FOR THE YEAR			$11,876.15

BUDGET COMPARISON—SOCIAL ACTIVITIES

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS—NEW YORK, N. Y.

For the Fiscal Year Ended October 31, 1945

INCOME

	Actual	Budgeted	Increases	Decreases
MEMBERSHIP INCOME DUES—RENEWALS				
100—Members	$ 20,936.70	$ 21,600.00	$	$ 663.30
101—Associates	12,494.79	10,800.00	1,694.79	
102—Juniors	1,336.00	1,400.00		64.00
103—Students	3.00	45.00		42.00
	34,770.49	33,845.00	1,694.79	769.30
DUES—NEW MEMBERS				
104—Members	1,836.00	2,700.00		864.00
105—Associates	2,619.00	1,080.00	1,539.00	
106—Juniors	347.50	400.00		52.50
107—Students	18.00	30.00		12.00
	4,820.50	4,210.00	1,539.00	928.50
TOTAL DUES INCOME	$ 39,590.99	$ 38,055.00	$ 3,233.79	$ 1,697.80
OTHER INCOME				
108—Initiation Fees	7,091.00	3,700.00	3,391.00	
109-110—Emblems and Certificate Frames	786.52	200.00	586.52	
	7,877.52	3,900.00	3,977.52	—0—
TOTAL INCOME FROM MEMBERS	47,468.51	41,955.00	7,211.31	1,697.80
INCOME FROM PUBLICATIONS				
115—Editorial Contract	17,249.96	17,250.00		.04
116—Guide Sales and Advertisements	60,797.22	54,000.00	6,797.22	
117—Sale of Transactions	1,560.63	700.00	860.63	
118—Income from Books, Reprints, Etc.	188.82	400.00		211.18
119—Sales Codes	—0—	25.00		25.00
120—Servicemen's Fees	1,014.50	450.00	564.50	
	80,811.13	72,825.00	8,222.35	236.22
INCOME FROM INVESTMENTS				
125—Interest — Savings Accounts	85.60	250.00		164.40
126—Interest—Securities	480.00	750.00		270.00
127—Interest — Cert. of Indebt.	1.82	5.00		3.18
	567.42	1,005.00		437.58
COLLECTION OF PRIOR YEAR'S DUES	2,196.50	1,500.00	696.50	—0—
TOTAL INCOME	$131,043.56	$117,285.00	$16,130.16	$ 2,371.60

EXPENSES

OPERATING EXPENSES				
150—President's Fund	$ 1,462.89	$ 2,500.00		$ 1,037.11
151—Council Travel to Meetings	1,348.40	2,500.00		1,151.60
160—Executive Commitee	13.43	100.00		86.57
161—Finance Committee	24.27	200.00		175.73
162—Membership Committee	1,063.50	2,500.00		1,436.50
170—Admissions and Adv. Comm.	421.48	500.00		78.52
171—Constitution and By-Laws	207.11	150.00	57.11	
172—Nominating Comm.	24.94	150.00		125.06
173D—Cardex Books to Chapters	154.76		154.76	
173B—Chapter Delegates Travel	3,745.26	3,300.00	445.26	
173C—Chapter Relations Committee	229.85	350.00		120.15
174—War Service Comm.		1,000.00		1,000.00
201—A.S.A. Membership	100.00	100.00		
204—Membership Certificates	1,069.49	200.00	869.49	
206—Medals and Awards	70.00	200.00		130.00
	9,935.38	13,750.00	1,526.62	5,341.24
MEETING EXPENSES				
163—Meetings	1,273.27	2,500.00		1,226.73
173A—Speakers to Chapters	1,253.99	1,500.00		246.01
327—Chapter Meeting Allowance	650.00	900.00		250.00
	3,177.26	4,900.00	—0—	1,722.74
PUBLICATION EXPENSES				
200—Members' Subscriptions, H.P.A.C.	7,667.07	7,500.00	167.07	
305-326—Guide Publ. and Distrib.	42,764.19	37,800.00	4,964.19	
202—Transactions	5,190.04	4,500.00	690.04	
203—Membership Roll	738.30	1,500.00		761.70
164—Standards (Including Codes)	5.46	150.00		144.54
207—Publication Comm. Expenses	97.55		97.55	
	56,462.61	51,450.00	5,918.85	906.24
HEADQUARTER'S EXPENSES				
210—Salaries—Secretary and Staff	25,762.48	30,000.00		4,237.52
211—Additional Compensation	4,449.14	3,200.00	1,249.14	
212—Traveling—Secretary and Staff	1,030.47	1,500.00		469.53
213—Rent and Light	3,803.82	4,000.00		196.18
214—Telephone	998.58	700.00	298.58	
215—Telegraph	333.10	200.00	133.10	
216—Postage	2,642.10	1,800.00	842.10	
217—General Printing	650.71	1,000.00		349.29
218—Office Supplies	894.55	600.00	294.55	
219—Addressing and Address Changes	221.79	250.00		28.21
220—Professional Services	950.00	800.00	150.00	
221—Bank Charges	82.21	100.00		17.79
222—Depreciation—Furn. and Fixt.	324.84	250.00	74.84	
223—General Office Expense	1,148.58	750.00	398.58	
TOTAL HEADQUARTER'S EXPENSES	43,292.37	45,150.00	3,440.89	5,298.52
LESS: 30% Charge to Guide	12,987.71	13,545.00	—0—	557.29
	30,304.66	31,605.00	3,440.89	4,741.23
INITIATION FEES TO RESERVE FUND	7,091.00	3,700.00	3,391.00	—0—
COUNCIL APPROPRIATION TO RESEARCH	10,000.00	10,000.00	—0—	—0—
TOTAL EXPENSES	$116,970.91	$115,405.00	$14,277.36	$12,711.45

BALANCE SHEET

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS—NEW YORK, N. Y.

October 31, 1945

ASSETS

RESEARCH FUND			
CASH ON DEPOSIT			
Treasurer's Account — Bankers Trust	$ 3,200.59		
Secretary's Account—Chase National Bank	956.72		
Director's Account — Cleveland Trust Co.	769.09		
Thrift Account—Bank for Savings	3,426.90	$ 8,353.30	
ON HAND FOR DEPOSIT			
Treasurer's Account — Bankers Trust Co.	4,945.15		
Director's Account — Cleveland Trust Co.	1,610.08		
Secretary's Account—Chase National Bank	2,921.62	9,476.85	
ESCROW FUNDS IN TRANSIT			
To the Cleveland Trust Co.		8,000.00	
ON HAND			
Cleveland, Ohio		50.00	$25,880.15
TRAVEL IMPREST FUND			200.00
PERMANENT			
Laboratory Equipment, Furniture and Fixtures	13,466.82		
LESS: Reserve for Depreciation.	1,580.08	11,886.74	
Tools and Supplies		300.00	12,186.74
DEFERRED CHARGES			
Prepaid Rent		1,325.00	
Withholding Taxes		63.20	1,388.20
TOTAL RESEARCH FUND			39,655.09
RESEARCH ENDOWMENT FUND			
CASH ON DEPOSIT			
Bank for Savings			596.91
			$40,252.00

LIABILITIES AND FUNDS

RESERVE FUND			
ACCOUNTS PAYABLE		$ 250.00	
DEFERRED INCOME			
PROJECT			
Summer Cooling	$ 1,859.45		
Air Friction in Ducts and Fittings	2,016.46		
Shock Effect in Summer Air Conditioning	66.50		
Weather Data for Design	600.00		
Heat Losses Due to Infiltration	188.75		
Solar Heat Gain of Insulated Walls	75.00		
Field Studies of Radiant and Panel Heating	91.66		
Gravity Circulation of Water	25.00	4,922.82	
DUES—MEMBERS AND ASSOCIATES			
40% of 1946 Dues Prepaid in 1945.		226.52	$ 5,399.34
RESEARCH FUND			34,255.75
TOTAL RESEARCH LIABILITIES AND FUND			$39,655.09
RESEARCH ENDOWMENT FUND			
Principal			596.91

NOTE "A"—There exists a contingent asset in the sum of $2,110.33 arising from 40% of the Society's members and associates dues pending collection by the Society.

NOTE "B"—This Balance Sheet is subject to the comments contained in the letter attached to and forming a part of this report.

$40,252.00

BUDGET COMPARISON

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS—NEW YORK, N. Y.

For the Fiscal Year Ended October 31, 1945

INCOME

	Actual	Budget Provision	Increases	Decreases
A.S.H.V.E.—Dues	$24,630.65	$25,120.00	$	$ 489.35
Contributions				
Navy Contract	1,600.00	1,600.00		
Earmarked	9,419.88	15,000.00		5,580.12
General	8,361.59	35,000.00		26,638.41
Special Allocation from Council	10,000.00	10,000.00		
Interest	50.82	80.00		29.18
TOTALS	$54,062.94	$86,800.00	—0—	$32,737.06

EXPENSES

Chairman and Committee				
Traveling	$ 608.02	$ 1,000.00	$	$ 391.98
Chairman's Office	340.45	600.00		259.55
Professional Services	250.00	200.00	50.00	
EXPENSES—(*Continued*)				
Research Laboratory				
Salaries — Administrative and Technical	21,490.52	41,000.00		19,509.48
Salaries—Clerical	5,088.60	5,200.00		111.40
Traveling	1,862.41	2,500.00		637.59
Postage	362.51	350.00	12.51	
Telephone and Telegraph	621.30	350.00	271.30	
Office Expenses and Supplies	585.03	500.00	85.03	
Printing and Multigraphing	572.72	600.00		27.28
Library and Periodicals	256.99	300.00		44.01
Laboratory Materials and Supplies	3,465.83	2,500.00	965.83	
Insurance	—0—	300.00		300.00
Depreciation—Equipment	1,239.37	750.00	489.37	
Unallocated	337.77	1,500.00		1,162.23
Taxes	2,180.00	2,000.00	180.00	
Property Insurance	168.40	200.00		31.60
Water, Gas, Heat and Electricity	1,109.71	1,300.00		190.29
Janitor Services and Supplies	1,274.09	1,000.00	274.09	
Building Maintenance	83.70	100.00		16.30
Cooperative Research	8,248.86	12,700.00		4,451.14
Navy Contract	1,600.00	1,600.00		
Special Council Appropriation	5,862.42	10,000.00		4,137.58
TOTALS	$57,607.70	$86,550.00	$ 2,328.13	$31,270.43

President Winslow then announced that the major business at the first session was the consideration of certain changes to be made in the Charter, Constitution and By-Laws.

On advice of the Society's legal counsel it was found necessary to revise the original Charter which had been in existence for 50 years in order to cover the various activities not specifically mentioned in the present Charter which were being carried on by the Society. L. P. Eisner, as legal counsel, prepared a revised Charter in the proper legal form and, as the proposed revisions had been submitted to the membership in advance of the meeting as required, the proposed changes were presented to the meeting for consideration and if approved in the meeting could be submitted to the proper authorities of New York State to replace the present Charter.

R. H. Carpenter, New York, N. Y., chairman of the Committee on Constitution and By-Laws, moved that the new Charter be adopted. The motion was seconded by Past President Homer Addams, New York. There was no discussion of the motion, which was passed unanimously, and President Winslow announced that the motion was carried and the proposed Charter was adopted.

CHANGE IN PURPOSES, POWERS AND OTHER PROVISIONS AND INCREASE IN NUMBER OF DIRECTORS

of

THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

The number of directors previously authorized is twelve (12). The number of directors as increased by this certificate hereafter shall be not less than thirteen (13) nor more than twenty-one (21). The Board of Directors shall be styled "The Council."

The purposes, powers and other provisions are as follows:

(a) To advance, promote and cultivate the arts and sciences of heating, ventilating, cooling and air conditioning and the allied arts and sciences.

(b) To conduct, promote and coordinate fundamental and practical research, and to study and develop new principles, uses, products, inventions and methods in the fields of heating, ventilating, cooling and air conditioning and the allied arts and sciences.

(c) To cooperate with universities, colleges, schools and other organizations and groups, including governmental agencies, for the investigation of research subjects.

(d) To promote the advancement of professional knowledge, educational programs and standards for the instruction and technical training of persons engaged in the engineering profession and students and teachers of heating, ventilating, cooling and air conditioning and the allied arts and sciences.

(e) To promote the interchange of knowledge and opinions and to publish, diffuse and disseminate in any language and in every form and medium now or hereafter known, information concerning heating, ventilating, cooling and air conditioning and the fields related thereto.

(f) To hold meetings and arrange events and programs for the reading and discussion of papers and the exhibition and display

of items in the fields of heating, ventilating, cooling and air conditioning and the allied arts and sciences.

(g) To produce, publish and foster, in any language and in every form and medium, publications, books, periodicals, programs, data, reports, standards, guides, educational programs and codes relating to heating, ventilating, cooling and air conditioning and the allied arts and sciences.

(h) To secure copyright registrations, Letters Patent, or equivalent protection, in the name of the corporation or others, in all countries of the world, of patentable inventions and discoveries and copyrightable writings and material, and to license the same and dispose thereof, in whole or in part, subject to the following provisos: (1) That the foregoing activities shall not be conducted with the view of pecuniary profit to the corporation or to any member, officer, director, agent or employee thereof; (2) that the surplus proceeds, if any, derived by the corporation from the foregoing activities shall be used only in furtherance of the corporation's objects and purposes and in the performance of its public obligations; and (3) that if a patentable invention or discovery be made for a copyrightable writing produced in cooperation with the United States Government, that the same may, at the option of the directors, be dedicated to the people or assigned, without consideration, in whole or in part, to the Government of the United States.

(i) To maintain a representative and centralized agency to consider and act upon matters affecting the design, construction, research, development and study of heating, ventilating, cooling and air conditioning and the allied arts and sciences.

(j) To maintain a centralized agency where engineers and persons engaged in the fields of heating, ventilating, cooling and air conditioning and the allied arts and sciences, may register and file biographical and other data for the confidential information of prospective employers.

(k) To encourage the establishment of and compliance with codes of ethics, codes and rules of practice, and fair standards of professional conduct; to encourage uniformity and certainty in customs and usages among those engaged in the practice of engineering and the arts and sciences of heating, ventilating, cooling and air conditioning and the industries related thereto; to cooperate with governmental agencies in the preparation of rules and standards for the licensing of professional engineers; and to notify agencies having disciplinary jurisdiction of unworthy and unauthorized practices.

(l) To develop good will and cordial relations among its members and persons practicing or teaching or studying the arts and sciences of heating, ventilating, cooling and air conditioning and allied arts and sciences and to foster among said members and persons a mutuality of interest and understanding.

(m) To assist in the formation of local chapters and student and other branches, and to regulate, operate and control the same under the direction and at the pleasure of the corporation, but no local chapter or branch shall subject the corporation to any financial or other obligation except such as the corporation may voluntarily assume.

(n) To receive, acquire, hold and maintain any property, real or personal, without limitation as to amount or value, for any of the corporation's objects, by way of bequest, devise, gift, purchase or lease, to invest and re-invest the same, to control the income therefrom, and to expand or otherwise dispose of all or any portion of its funds and property, including the income, interest or principal.

(o) To cooperate with and contribute to universities, colleges, schools and other organizations and groups having the same or similar objects; to establish scholarships and make awards in recognition of notable scientific achievement or outstanding services performed in the fields of heating, ventilating, cooling and air conditioning or the allied arts and sciences.

(p) To do any and all things necessary or proper in connection with or incidental to any of the foregoing.

(q) No substantial part of the activities of this corporation shall be the carrying on of propaganda or otherwise influencing or intending to influence legislation.

(r) The territory in which the corporation's operations are principally to be conducted is in all parts of the United States and its possessions and in the Dominion of Canada, but the corporation may on occasions extend its operations to other parts of the world.

(s) No officer, director or member of this corporation shall receive or be lawfully entitled to receive any part of the net earnings thereof or any pecuniary profit from the operations thereof, except such reasonable compensation for services in effecting one or more of its purposes as the Board of Directors may determine.

(t) Each director of the corporation shall be indemnified by the corporation against expenses actually and necessarily incurred by him in connection with the defense of any action, suit or proceeding in which he is made a party by reason of his being or having been a director of the corporation, except in relation to matters as to which he shall be adjudged in such action, suit or proceeding to be liable for wilful negligence, misfeasance or misconduct in the performance of his duties as director; such right of indemnification shall not be deemed exclusive of any other right to which he may be entitled under any by-law, agreement, vote or otherwise.

President Winslow then referred to the proposed amendment to Article B-VIII, Section 11, of the By-Laws referring to a change in the number of members and the method of electing members of the Nominating Committee. He stated that the Society had considered the subject of the proposed amendment at least three times at previous Annual Meetings and that the present proposed amendment had been prepared in accordance with action taken at the 51st Annual Meeting in Boston. It was not an action suggested by the Council or by the Committee on Constitution and By-Laws, but the proposed amendment resulted from the deliberations of the Society at the Boston meeting. Mr. Carpenter then explained that the Committee on Constitution and By-Laws had prepared the amendment in accordance with instructions with only such changes as were necessary to make it work. He read the resolution adopted at the 51st Annual Meeting at Boston, which was as follows:

> THAT the resolution be referred to the Council for transmission to the Constitution and By-Laws Committee with instructions to present the resolution in proper form for Society action at a later meeting.

Mr. Carpenter announced that a copy of the proposed amendment had been mailed to each member of the Society under date of December 15, 1945, as required by the By-Laws.

It was moved by Mr. Carpenter and seconded by E. M. Mittendorff, Chicago, that the proposed amendment to Article B-VIII, *Section 11*, of the By-Laws be adopted.

President Winslow declared that the motion was now ready for discussion.

F. W. Legler, Minneapolis, said that Minnesota Chapter had discussed the proposed change. He stated that at the Boston meeting there was considerable opposition to the change and felt that the number of members present at Boston was not sufficient to obtain a representative consideration. He believed the appointment of 11 members or 40 per cent of the Nominating Committee would be an undemocratic procedure and proposed that all of the members should be elected. He did not object to reduction of the number of members of the committee from 37 to 11.

B. L. Evans, St. Louis, agreed with Mr. Legler and offered the additional objections that a representative of a region could not determine which chapter members might be qualified to be Council members or national officers.

H. R. Allonier, Columbus, stated that he was presenting an opinion for Central Ohio Chapter in stating that the small number of members in the meeting would be unable to decide an issue that involved all of the chapter members. He suggested that the proposed amendment should be submitted to the Society membership by letter ballot. He also stated that a Nominating Committee of 37 members was not an unwieldy committee.

President Winslow stated that amendments to the Constitution can be adopted by letter ballot but that the By-Laws could be amended only by a vote at a meeting of the Society.

M. W. Bishop, Milwaukee, favored a reduction in the size of the Nominating Committee. He also believed that the proposed arrangement would be more acceptable to all members than any previous method that had been used. He pointed out that the geographical distribution of the pro-

posed plan seemed to be out of line because of the variation in number of members in the different zones, which he found to be as follows: zone 1, 2 chapters, 134 members; zone 2, 6 chapters, 708 members; zone 3, 8 chapters, 751 members; zone 4, 400 members; zone 5, 427 members; zone 6, 273 members; zone 7 (Canadian zone), 253 members. Since a representative from each zone would have one vote, it was obvious that the number of votes was not proportional to the number of members in the zones. He suggested that the distribution of membership could be improved if New York State were moved from zone 2 to zone 1 and Ohio were moved from zone 3 to zone 2. The distribution of membership would then be zone 1, 5 chapters, 488 members; zone 2, 6 chapters, 594 members; zone 3, 5 chapters, 511 members. Then if the remaining zones were unchanged, the resulting distribution would give the membership a more nearly equal share in the nomination of officers. While he felt unable to support an arrangement in which 135 members in one zone would have equal vote with 754 or 705 in other zones, he believed that the rearrangement which he proposed would obtain a general support of the proposed amendment.

President Winslow asked Mr. Bishop whether he wished to offer an amendment but Mr. Bishop preferred to determine first whether there was sufficient support for his suggestion.

President Winslow stated that any amendment which changed the fundamental intent of the proposed amendment would not be in order, but a change in the definition of zones would be a modification of detail and would therefore be in order.

M. F. Blankin, Philadelphia, remarked that the election of four members of the committee by the Council had been suggested in order to obtain representation for a large number of Society members who were not members of any chapter. He agreed with the suggestion for rearrangement of chapters which had been proposed by Mr. Bishop. Mr. Blankin stated that it would be necessary to act upon the proposed amendment because with the increase in number of Chapters, the Nominating Committee would soon consist of 50 to 60 members.

L. T. Avery, Cleveland, stated that a mail questionnaire submitted to the membership following the 49th Annual Meeting at Cincinnati proved to be a failure because members were too busy or neglected to express an opinion. He stated that the method of amending the By-Laws could be changed only by a change in the By-Laws. Mr. Avery pointed out that according to the new Charter the Council would consist of not less than 13 nor more than 21 members. The Council would elect four members of the Nominating Committee and none of these members nor any of the seven members elected by the Chapter Delegates would be Council members. It was, therefore, obvious that the Council could not be a self-perpetuating group. The procedure was therefore democratic.

Mr. Legler asked why all members of the Nominating Committee could not be elected by the membership.

President Winslow replied that the method of electing Nominating Committee members was in accordance with the resolution adopted by the membership and was not therefore an attempt by the Council to get more power. He suggested that since the suggestion for a change seemed to arise every other year and since the Council had never taken a stand on the matter nor initiated any of the proposed changes, the Society should make a final decision regarding the matter.

Mr. Carpenter emphasized the point made by Mr. Blankin that the four members chosen by the Council would represent members not affiliated with Chapters. On January 1, 1945 the total chapter membership was 2905, which was about 65 per cent of the total membership—which was approximately 4300. It was therefore obvious that the Nominating Committee represented the 2905 members. He also pointed out that the Chapter Delegates Committee as now constituted, Oklahoma Chapter with 11 members had exactly the same representation as Philadelphia with 137, Southern California with 210, or New York with 230 members.

Mr. Avery inquired whether there was a basis for geographical division into zones and Mr. Carpenter replied that the letter mailed to the members with the proposed amendment contained an explanation, but that he was not at all satisfied with the final distribution of the zones. He believed that the suggestion that New York be moved into the New England group was a good one.

Brig.-Gen. W. A. Danielson, Memphis, stated that with growth of the Society it was only natural that geographical units be formed if the organization were to function smoothly. This procedure had been followed satisfactorily in the *American Institute of Electrical Engineers* for 30 years. Regions, he stated, should be based upon two factors, the number of members and the ability of the members to work together.

J. S. Locke, Chicago, Ill., announced his objection to the proposed amendment which had been discussed at meetings of the Illinois Chapter and its Board of Governors with a consensus of opinion in favor of the present procedure. He believed that the most active members were those who were affiliated with chapters and therefore opposed the election to the Nominating Committee of four members not affiliated with chapters.

J. D. Kroeker, Portland, Ore., said the far western chapters were in favor of the proposed amendment although certain features such as zoning might need to be changed at a later date. The western chapters had requested him to mention that they could not bear the cost of sending representatives to the Annual Meetings and that the arrangement made by the Council from year to year to provide traveling expenses had not been made a part of the By-Laws or the Constitution. Since the proposed amendment made provision to pay the traveling expenses of the Nominating Committee it was probable that the payment of expenses of delegates to the Annual Meeting would be eliminated. Mr. Kroeker suggested that it was desirable that delegates' expenses to the Annual Meeting be paid and that the matter should be considered by the Society.

President Winslow stated it would be necessary to revise the Constitution upon the adoption of the new charter and that in doing so there would be a good opportunity to make such minor changes as might be found advisable. He emphasized the importance of determining at this meeting the policy of the membership in regard to the type of Nominating Committee which was desired.

Mr. Blankin requested that a portion of the By-Laws concerning the election of Chapter Delegates be read.

S. L. Furber, Kansas City, Mo., said that members of Kansas City Chapter were in opposition to the proposed amendment, particularly the provision that the Council elect four members. He asked whether the Society was an organization of chapters or of individual members and believed that the members not affiliated with chapters should be encouraged to become chapter members.

President Winslow read the section of the By-Laws requested by Mr. Blankin.

ARTICLE B-VIII, *Section* 14. There shall be a standing committee known as the Chapter Delegates Committee. The membership of this Committee shall consist of one Delegate or Alternate from each local chapter, who shall be selected as each chapter may direct. The Chapter Delegates Committee shall meet at each Annual and Semi-Annual Meeting of the Society to discuss problems of mutual interest affecting the chapters. The Chapter Delegates shall elect a chairman to serve for a term of one year, from June to June. Meetings of the Chapter Delegates Committee may be attended by any local chapter officer, but each chapter shall have only one vote.

G. L. Tuve, Cleveland, Ohio, stated that he had lived in Cleveland or the section of the United States west of Cleveland and had always supported the idea of geographical representation of the west. He believed that some of the outstanding Society members were not chapter members.

Mr. Tuve stated that members who spent several hundred dollars a year to be able to serve on the Council evidently began to grow horns and a tail. He pointed out that many members serve on the Council and pay their own expenses and that because of doing so were no longer responsible enough to be elected Society officers. He suggested that the meeting should not turn down the proposed amendment.

H. J. Ryan, New York, N. Y., remarked that in a thickly populated area such as New York the chapter with its 230 members did not represent the entire national Society membership which was about 450 in the area. He had found that in the New York area many members did not affiliate with the chapter because the nature of their work rather than personal inclination prevented them from participating. He felt that if a chapter included only a portion of the national Society members, within its area it should not properly attempt to represent all of the members. It was therefore desirable that members not affiliated with chapters should express their opinion regarding the proposed amendment.

J. H. Van Alsburg, Holland, Mich., spoke as a member who had belonged to four chapters. He referred to the difficulty of attending meetings of certain chapters where the area covered was large. In his experience he had found that a large Nominating Committee required much time to do its work and suggested that the proposed reduction in number of members would be an advantage. Mr. Van Alsburg offered an amendment to the proposed amendment to Article B-VIII, *Section* 11, seconded by Mr. Blankin.

> THAT New York State be transferred to Region 1 and that Ohio be transferred to Region 2.

The amendment was adopted.

R. A. Sherman, Columbus, Ohio, spoke of the satisfactory experience of the *ASME* in which it was necessary to establish eight regions for its 18,000 members. He believed that a smaller committee could do a better job than the present Nominating Committee of 37 members, but was not sympathetic to the idea that the Council should elect four members. He inquired whether the Constitution and By-Laws Committee had considered the possibility of making it mandatory that the four members to be elected by the Council should be chosen from non-members of Chapters. He therefore offered an amendment to the proposed amendment to Article B-VIII, *Section* 11, which was seconded by Mr. Kroeker,

> THAT the clause "four members and one alternate shall be chosen by the majority of the Council" be changed to read "four members and one alternate shall be chosen from members who are not affiliated with Chapters by a majority of the Council."

Mr. Avery remarked that the amendment proposed by Mr. Sherman would have the effect of rewarding those members who do not belong to chapters. He believed that the selection could be safely left to the Council to pick worthy members regardless of affiliation with chapters.

President Winslow called for a vote on the amendment proposed by Mr. Sherman and declared that the motion was lost.

W. M. Wallace, II, Durham, N. C., expressed his opposition to the proposed amendment because he believed that 37 members of the Nominating Committee would be more representative.

Edwin Elliot, Philadelphia, Pa., stated that according to his experience as an alternate on the Nominating Committee on several occasions members of the committee who attended January meetings invariably did not come to the following summer meeting. By having a smaller Nominating Committee for which traveling expenses would be paid, it would be certain that the committee members would be present at the summer meeting when final nominations would be made. He pointed out that all chapters would have a voice in the selection through their delegates which were sent to the January meeting each year and that what would actually happen would be that the Chapter Delegates would select a smaller Nominating Committee. He, therefore was heartily in favor of the proposed amendment.

E. K. Campbell, Kansas City, Mo., stated that Kansas City Chapter had considered the amendment in special committees and at a chapter meeting and had instructed him to vote against it. He did not believe that the present committee was so large as to cause confusion in reaching a decision. He suggested that if the Society would pay the railroad fare of the present members of the Nominating Committee to the summer meeting a full attendance could be assured.

Mr. Locke suggested that consideration of the proposed amendment should not depend upon the personalities of Council members. He believed that the election of four members at one meeting of the Council would result in the selection of four who were of the same general type and, since they would be apt to think alike, they would tend to control the action of the entire Nominating Committee.

Requesting that only Members and Associate Members vote, President Winslow called for a rising vote and asked that Mr. Ryan and Secy. A. V. Hutchinson act as tellers. Following the vote President Winslow announced that the proposed amendment, which follows, had been passed by a vote of 81 to 47.

AMENDMENT TO ART. B-VIII, SECTION 11 OF BY-LAWS

Article B-VIII, *Section 11*, The Nominating Committee shall consist of eleven (11) members eligible to vote who have been in good standing continuously for five (5) years prior to their selection. Four (4) members and one (1) alternate shall be chosen by majority vote of the Council at its last quarterly meeting of the calendar year. Seven (7) members and one (1) alternate shall be chosen by majority vote of the Chapter Delegates Committee on the first day of each Annual Meeting. The Secretary of the Society shall notify the Chairman of the Chapter Delegates Committee not later than December 1st of the names of the four (4) members and alternate selected by the Council.

Each regional area as defined in *Section 11A* must be represented on this Committee but not more than one (1) member may be elected from any Chapter and not more than two (2) members may be elected from any regional area. Members of the Council are not eligible to serve on the Nominating Committee.

The Nominating Committee shall select eligible nominees for the office of President, First Vice-President, Second Vice-President, Treasurer, four (4) members of the Council and any other elective office that may have become vacant since the last annual election.

All members of the Nominating Committee who are present at the Annual Meeting shall be subject to the call of the Secretary of the Society on the last day of the Annual Meeting for the purpose of effecting its own organization and election of a permanent Chairman and Secretary. If a quorum is not available a temporary Chairman and Secretary shall be selected from the eligible Committee members and a permanent organization shall be established by correspondence or otherwise under the direction of the temporary Chairman. The Committee shall hold a formal meeting during the Semi-Annual Meeting of the Society for the final selection of nominees to which round trip railroad fare and lower berth expenses shall be paid by the Society to each Committee member and alternate attending. In case a Semi-Annual Meeting is not held the Committee must be called in a special meeting by the Chairman not later than September 1st of each year. In this event notice of such meeting shall be sent to all members and alternates by the Committee Secretary thirty (30) days prior to the date of such meeting. Expenses as previously outlined shall be paid to such special meeting.

Seven (7) members of the Nominating Committee shall constitute a quorum. Each member shall be entitled to vote for one (1) nominee for each office to be filled with the candidates receiving the highest number of votes receiving the nominations. The alternates may attend meetings of the Committee but shall have no vote except in the absence of one of the members with whom they are chosen.

The Nominating Committee shall certify the names of the nominees with their written acceptance to the Secretary of the Society prior to September 15th and the names of the candidates shall be published in the October JOURNAL of the Society.

Section 11A. Regional areas are defined as follows:

Region 1.

Maine	New Hampshire
Vermont	New York
Massachusetts	Rhode Island
	Connecticut

Region 2.

Ohio	Delaware
New Jersey	Maryland
Pennsylvania	Dist. of Columbia

Region 3.

Indiana	Michigan
Illinois	Wisconsin

Region 4.

Minnesota	North Dakota
Iowa	South Dakota
Nebraska	Montana
Missouri	Wyoming
Kansas	Colorado
	New Mexico

Region 5.

Idaho	Washington
Utah	Oregon
Nevada	Arizona
	California

Region 6.

Virginia	Mississippi
West Virginia	Kentucky
North Carolina	Tennessee
South Carolina	Louisiana
Florida	Arkansas
Georgia	Oklahoma
Alabama	Texas

Region 7. The Provinces of Canada.

President Winslow then proposed consideration of the amendents to the Constitution and By-Laws which had been submitted to the membership on December 15, 1945, and requested that R. H. Carpenter, chairman of the Constitution and By-Laws Committee, make a statement on them. Mr. Carpenter stated that the amendments to **Article C-XI,** *Section* 1, and **Article B-XI,** *Section* 3, were proposed in order to reduce the number of different funds within the Society. The creation of a building fund had led to the proposed change and the Finance Committee had recommended it as a means of facilitating the administration of Society funds.

Mr. Carpenter stated that the proposed amendment to **Article B-VIII,** *Sections* 5, 8, *and* 10, served to define the functions of the Meetings and Publications Committees and to establish a Constitution and By-Laws Committee which would be able to act independently of the Council in proposing amendments. At the present time the Constitution and By-Laws Committee could consider only such amendments as might be originated by the Council and assigned to the committee.

Article B-XII, *Section* 1, was offered as a clarification of the present provision. It was moved by Mr. Carpenter, seconded by Mr. Blankin:

THAT the proposed amendments to the Constitution and By-Laws be adopted as follows:

AMENDMENTS TO CONSTITUTION AND BY-LAWS

Art. C-XI—Funds—*Section 1*—The collection, deposit, disbursement and investment of all funds of the Society shall be subject to the direction of the Council.

Art. B-VIII—Committees—*Section 5*—The Meetings Committee shall select from the papers which have been approved by the Publication Committee or Committee on Research the papers for presentation at the technical sessions of the Annual and Semi-Annual Meetings, and shall assist the Publication Committee in securing desirable papers. Additional duties shall be as provided in the Rules.

Art. B-VIII—Committees—*Section 8*—There shall be a Publication Committee of three (3) members appointed by the Council for a term of three (3) years, the term of one (1) member expiring each year. This Committee shall receive and examine all papers and written discussions intended for presentation by the Society, except those under the jurisdiction of the Committee on Research, and shall accept for publication such as it may approve. It shall approve for publication the Transactions of the Society containing the papers, discussions and abstracts of the Society and of the Council.

Art. B-VIII—Constitution and By-Laws Committees—*Section 10*—At the first meeting of the Council after the Annual Meeting, the President shall appoint a Committee on Constitution and By-Laws which shall have supervision of all matters affecting the Constitution, By-Laws and Rules. This Committee shall consist of three (3) members, and shall report in writing to the Council on all actions taken which affect the Constitution, By-Laws and Rules.

Art. B-XI—Funds—*Section 3*—An Endowment Fund for research and such other purposes devoted to the art of heating and ventilating and air conditioning, as determined by the Council, may be established. The interest or income from this fund shall be used each year in a manner and for purposes as determined by the Council. The principal shall remain intact and shall be deposited in banks or invested in a manner provided by *Section 1* unless otherwise directed by a vote of the membership conducted in the same manner as provided by Art. B-XVI.

OMIT SECTION 7 AS FOLLOWS:

Art. B-XI—Funds—*Section 7—The current Research funds shall be handled separately from the funds of the Society, in accordance with the By-Laws of the Society and the Regulations which govern the Committee on Research. Surplus Research funds shall be invested by the Council in accordance with Section 1.*

Art. B-XI—Funds—*Section 8*—Re-number this *Section* 7 and amend to read as follows: *Section* 7—A Society Reserve Fund shall be created into which all admission fees and such other monies as the Council may direct shall be placed until the fund totals a sum equal to fifteen dollars ($15.00) per member, or fifty thousand dollars ($50,000), whichever is smaller. This Reserve Fund is to be used only in cases of emergency when current Society revenues are not sufficient to pay necessary expenses. Withdrawals not to exceed twenty per cent (20%) of the fund in any calendar year may be authorized by the Society at any meeting provided it has been recommended by the Council. Investments shall be made in accordance with *Section 1* of Art. B-XI. Interest earned on the Reserve Fund shall be added to current Society income.

Art. B-XI—*Section 8*—A Capital Fund shall be created in which all other monies shall be placed from which the funds for the Society and the Research operations shall be annually appropriated in accordance with the budgets approved by the Council.

Art. B-XII—Publications and Papers—*Section 1* — *A* JOURNAL carrying papers approved by the Publication or Committee on Research, news items of Society interest, and such other material as may be decided by the Council, shall be published monthly.

President Winslow called for a vote and announced that the motion was carried.

Mr. Ryan, chairman of the Board of Tellers of Election offered the following report:

Report of Tellers of Election

		For
President—Alfred J. Offner		1184
1st Vice President—Baldwin M. Woods		1186
2nd Vice President—G. L. Tuve		1186
Treasurer—J. F. Collins, Jr.		1186
Members of Council:	E. G. Carrier	1186
	F. W. Hutchinson	1185
	R. A. Sherman	1185
	M. S. Wunderlich	1183

Scattering votes for other candidates:

For President	1
For Council	3

Chairman Ryan of the Board of Tellers on the election of the Committee on Research offered the following report:

BALLOTS FOR COMMITTEE ON RESEARCH

L. N. Hunter	1186
C. O. Mackey	1186
R. D. Madison	1186
L. G. Miller	1186
L. P. Saunders	1186

Scattering votes for other candidates:
None.

BOARD OF TELLERS
H. J. Ryan, Chairman
R. W. Cumming
F. D. McCann

January 22, 1946.

The meeting was adjourned at 4:00 p.m.

Second Session—Tuesday, January 29, 9:30 A.M.

The second session convened at 9:45 a.m. with Pres. C.-E. A. Winslow, New Haven, Conn., presiding. R. C. Cross, Chicago, presented the paper, A Study of Several Coal-Fired Magazine-Feed Space Heaters, by R. C. Cross and H. N. Ostborg (published in January 1946 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

S. K. Smith, Westfield, Mass., asked Mr. Cross to make some further comments regarding the CO found in the test of heater F which showed an appreciable amount of

CO. Mr. Cross explained that because there was lack of control of secondary air in most cases, the CO_2 content was usually low, the oxygen content high, and the CO content negligible except in the case of the underfired heater. Heater F, since it could be operated either as an over-feed or an under-feed type, produced a rather high percentage of CO at the start of the period with the result that there was a CO loss for the complete test period.

O. O. Oaks, Raritan, N. J., presented his paper, Application of High Temperature Liquid as a Heat or Energy Transfer Medium for Domestic and Industrial Uses (published in January 1946 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

P. A. Green, Philadelphia, Pa., inquired about the size of fan, air delivery, and type of core used in the unit heater. Mr. Oaks replied that the size of the outlet of the heater was 10 in. x 13 in. It was constructed of three rows of ⅝ in. diameter plain copper tubing and had a total heating surface of 7.6 sq ft. As details of the performance of the heater were given in the text the author referred Mr. Green to the paper.

R. L. Stinard, New York, N. Y., inquired about the relative cost of the heating system proposed by the author and a conventional steam or hot water system for residence use. The author stated that the subject of relative cost was somewhat controversial and for that reason had not been included in the paper. Mr. Oaks expressed the opinion that the apparatus could be built at no greater cost than present equipment used to supply the same service in the home, and that the operating cost might be 50 per cent less than for conventional heaters and appliances.

H. M. Nobis, East Cleveland, Ohio, asked about the cost of the liquid, how it was sold, and whether it remained stable in operation. The author stated that the liquid at present had not reached a production stage and that therefore costs were somewhat higher than would be expected later. The present manufacturer of the liquid had stated that the liquid could be sold at 50 cents a gallon when produced commercially. Mr. Oaks believed that the replacement requirement by a householder might not exceed one gallon in five years. After two years use of the liquid in the pilot plant chemical analysis indicated that no deterioration in the liquid had taken place even though the liquid had been taken out of the system many times and exposed to the air. At the end of the two-year period, the liquid seemed to be exactly in its original condition.

B. M. Brod, Jackson Heights, N. Y., inquired about the possibility of using the liquid as a substitute for brine in low temperature refrigeration plants. Mr. Oaks replied that the specific heat of the liquid was 0.43 and that if used in place of brine approximately twice as much liquid would need to be circulated to produce the same results. As stated in the paper the viscosity of the liquid was similar to SAE 20 oil at 70 F although very fluid at 100 F. At low temperatures the higher pumping rate due to low specific heat and the viscosity of the liquid at low temperature might be disadvantageous although it had been found that the liquid could be pumped at—65 F.

H. F. Brinen, Racine, Wis., inquired whether difficulty had been found in retaining the liquid in piping connected by screw or flange joints. He also inquired about the surface tension of the liquid. Mr. Oaks stated that in the pilot plant all types of joints, iron, brass, copper, screw, welded and soldered (silver solder) joints had been used. It had been found necessary to make very good joints because the surface tension of the test liquid at high temperatures was lower than that of some other liquids.

L. L. Garey, Newark, N. J., inquired whether the product was a commercial one, and the author replied that arrangements were being made for its production in large quantities.

Mr. Stinard asked about the time required for cooking with the liquid compared with that required when using an electric or gas range. The author replied that cooking surface temperatures up to 700 F would be available, but that no cooking operation required more than 550 F. Except for toasting which required the higher temperature, all other heat requirements could be supplied by an outgoing temperature of 600 F. The author felt that the cooking time was less than with either gas or electricity and gave an approximate estimate of 25 to 30 per cent saving in time.

Society Treasurer L. P. Saunders, Lockport, N. Y., assumed the chair and presented Prof. F. W. Hutchinson, Lafayette, Ind., who gave an abstract of his paper, A Single-Equation Design Procedure for Radiant Panel Systems (published in December 1945 JOURNAL SECTION. *Heating, Piping & Air Conditioning*).

R. G. Vanderweil, Waterbury, Conn. (written): As the single equation solution presents a very important development in the computation of the heat balance of radiantly heated rooms Professor Hutchinson is to be congratulated for doing away with 4 of the 7 original simultaneous equations. If I discuss this new method and compare it with others, it is because I hope that a discussion will eventually result in further simplification of the single-equation method.

When reviewing the existing computations, we can group them basically into two methods—the rational and the approximate methods.

When using the 7-equation method by Professors Raber and Hutchinson, and—by trial and error—solving for *both*, the various room temperatures and the conductances resulting from these temperatures, we have employed a fully rational method. In the same manner, rational methods suggested by van der Held and myself may be solved.

Whether we use the single-equation method, as presented in this paper, or methods similar to that suggested by Professor Giesecke, we are confronted with approximate results.

In the rational method, there are no assumptions and both the conductance and temperatures are computed. A heat balance is established for each room enclosure. The approximate time required for a solution is one day per room. The final result is the heat output of the panel.

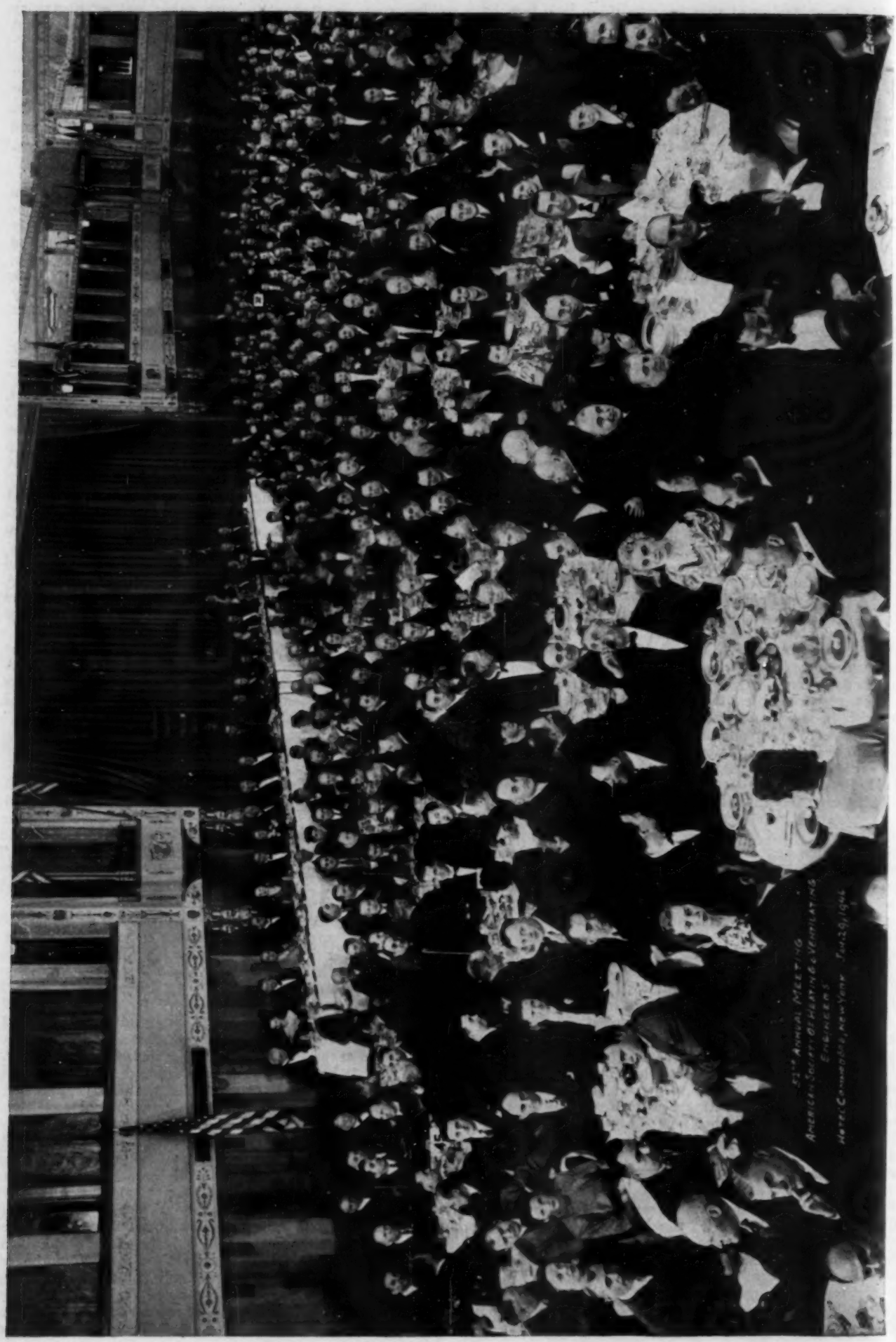
In the first approximate method as used by Professor Hutchinson the conductances h and h_r are assumed. A number of walls of various properties is replaced by one wall of constant property. The result is "one actual heated area and one equivalent (hypothetical) unheated area," thereby reducing the number of heat flow components to three. The time required for solution is about 40 min and the final result is the heat output of the panel.

In the second approximate method as used by Dr. F. E. Giesecke and others, temperatures t_s and t_r are assumed. A number of walls of various properties is replaced by one wall of constant property. The result is "one actual heated area and one equivalent (hypothetical) unheated area," thereby reducing the number of heat flow components to three. The time required for solution is 40 seconds and the final result is the heat output of the panel.

In the following, we are comparing the two simplified methods when applied to rooms using conventional ventilation. Professor Hutchinson assumes a mean conductance $h = 0.7$ which is composed of several components that actually may vary from $0.3 < h < 1.3$ and a mean $h_r = 1.08$ whose components may actually vary from $0.6 < h_r < 1.2$. From these conductances, the temperatures are derived. The methods of the second group of these simplified equations are to assume the temperatures and compute the conductances. It is granted that the assumptions of this group are not only less consistent, but also that its computations must yield results deviating more from actual conditions than the results obtained from the Hutchinson method.

However, unless Professor Hutchinson will make available in the future a less complicated solution, I dare say that the average engineer will still be inclined to use one of the methods assuming the room temperatures rather than the conductance. For practical design problems, it will be hard to find sufficient time to spend ½ hr or more on the computation of the heat balance of each individual room, particularly if we consider that thereafter the essential dimensions of the heating coil (tube spacing, water temperature, etc.) have to be computed for each room.

The room heat balance in a 12-room home may be computed within 10 min, when using the less accurate method,



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but will require a full day's work when using the one equation solution. And this less accurate method is, by no means, cruder than that used when computing conventional heating systems.

May I express my hope that Professor Hutchinson, who so brilliantly developed this and the previous computation methods, will present us with an even simpler method that is brief enough to be used for everyday design.

Ferdinand Jehle, Indianapolis, Ind., stated that probably most of the members and audience had not read Professor Hutchinson's paper and suggested that it would be well if Professor Hutchinson would explain the main features. Professor Hutchinson reviewed the main features and explained the derivation of equations by illustrations on the blackboard.

John James, Cleveland, Ohio, asked Professor Hutchinson to write the single equation on the board, but Professor Hutchinson stated that the equation was so complicated that the audience would refuse to believe it. The author stated that the object of presenting the single equation was to make it possible for anyone who was willing to devote the necessary time and labor to make the necessary substitutions to arrive at the final answer. No skill in mathematics was involved in making the substitution. He had proved that children could solve a problem by following the procedure outlined.

Professor Hutchinson, in reply to Mr. Vanderweil, stated that the socalled radiation factor h_r was a number representing the combined influence of about seven different factors, among which were the visibility factor, the shape factor of the panel with respect to other surfaces, variations in surface emissivity of each of the unheated surfaces. The value 1.08 for h_r was used in an original paper by the authors in 1941 and the author had found no reason to make a change. Professor Hutchinson stated that Mr. Vanderweil and he had talked about this subject for many years and were still in disagreement regarding it. He pointed out that the object of attempting to provide a single equation solution was to overcome the objections to the use of the usual heat loss method which had been found unsatisfactory. The suggested equation would make possible a solution which would be somewhat better than the approximate solution obtainable by the heat loss method. Professor Hutchinson paid tribute to C. S. Leopold, W. L. Fleisher, and Prof. B. F. Raber, whose work had been an inspiration to him in his studies of radiant panel heating.

Chairman Saunders stated that a very sincere vote of thanks was due to Professor Hutchinson for the careful and competent manner in which he answered the many questions which had arisen.

The session was adjourned at 11:45 a.m.

Third Session—Tuesday, January 29, 2 p.m.

The third session was called to order at 2:15 p.m. by Pres. C.-E. A. Winslow, New Haven, who requested President-elect A. J. Offner, New York, to take the chair.

Dean John A. Goff, Philadelphia, presented an abstract of the paper, Low-Pressure Properties of Water from −160 to 212 F, by John A. Goff and S. Gratch (published in February 1946 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

W. N. Murray, Moline, Ill., inquired whether Dean Goff had obtained any new value for the ratio of c_p/c_v which would improve the accuracy of present values in the literature at low pressures.

Dean Goff replied that the authors had not computed the ratio but that they had presented a formulation of the properties from which the ratio could easily be computed for all values down to zero pressure. The author pointed out that the work upon which the paper was based had established the reliability of the spectroscopic data and that it had been found possible to compute values from the spectroscopic data which would correlate better with Bureau of Standards measurement than had hitherto been possible by the empirical method used by the Bureau of Standards. The authors had established that the predictions of modern physics could be relied upon in computing values for zero pressure.

The next paper, Therapeutic Uses of Low Temperature, was presented in abstract by the author, Frederick M. Allen, M.D., New York, N. Y. (published in December 1945 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

C. P. Yaglou, Boston, Mass. (written): Dr. Allen has brought into our Society first-hand information on new possibilities of refrigeration in the therapeutic field. Although local body cooling by means of ice bags has long been in use for the relief of pain and swellings, nothing exciting developed until just before and during the war, when anything that looked at all promising in saving life or limb was given a fair trial.

As Dr. Allen implies in his most informative paper, some of the results in human refrigeration have far exceeded expectations, while others are still in the speculative state. Old conceptions about cold and disease, limits of adaptability to cold, effects of sudden temperature changes, etc., will have to be revised in the light of recent findings. A fruitful field has been opened for investigation and the ultimate findings will undoubtedly affect the practice of air conditioning for comfort, health and therapeutics. I would therefore propose that Dr. Allen's request for assistance and cooperation be given cordial consideration by our Society.

Dr. Allen remarked that very little is known about the biology of cold. Practical experience had given little idea of the broad theoretical relations of reduced temperature to life, or the conditions prevailing when some organism had been reduced to the temperature of liquid hydrogen and still survived, while others were killed very quickly at very mild temperatures. The work to date suggested great possibilities for investigation in one of the least known fields of biological knowledge.

The paper, Heating and Ventilating for Transport Airplanes, by B. M. Brod, was presented in abstract by the author (published in January 1946 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

Meyer Faktor, Chicago, Ill., stated that the heating system appeared to be operated on the gravity principle, as no blower was shown. Mr. Brod replied that in flying through the air at a speed of about 120 mph the impact pressure was equal to 9 in. of water. The ramming action of the airplane was sufficient to operate the system at a pressure loss of about 5 in. In combustion type heaters the pressure loss through the air passages at certain temperatures varied from 3 to 5 in.

J. H. Carbone, New York, N. Y., inquired about the air temperatures at the outlets adjacent to the seats. Mr. Brod replied that with steam systems since the heat loss in the duct was rather large, temperatures in the outlets nearest the radiator varied from 130 to 140 F in severe weather and were reduced to as low as 90 F in mild weather. At outlets located near the rear of the cabin the outlet temperature due to the heat loss in the duct would be 30 to 40 deg below the temperature at the front outlets.

The meeting was adjourned at 3:10 p.m.

Fourth Session—Wednesday, January 30, 9:30 a.m.

The fourth and final session convened at 9:45 a.m. with Pres. C.-E. A. Winslow, New Haven, presiding. Dr. Winslow announced that the registration was 514 members, 134 guests, 77 ladies, a total of 725.

Prof. G. L. Tuve, Cleveland, chairman of the Committee on Research, presented the report of the Committee on Research (published in February 1946 JOUR-

NAL SECTION, *Heating, Piping & Air Conditioning*). He stated that the research program of the Society was now greater than before the war and that the expenditures from November 1, 1944, to October 31, 1945, were $58,000. In addition to the research work that had been done, much progress had been made in the improvement of the research organization and in the building up of an excellent staff at the Research Laboratory. He referred to the report of the Director of Research which would be included with the annual report of the Committee on Research. Chairman Tuve referred to the close link that had been established between the Research Laboratory and the Guide Publication Committee, which would reduce the time lag between the completion of tests at the Laboratory and the incorporation of the data in THE GUIDE. The chairman considered it extremely important that the U. S. Public Health Service had agreed to supply a senior engineer of the service to the laboratory for the purpose of accelerating the studies in the relationship of air conditioning and ventilation to industrial hygiene.

About three dozen committee meetings had been held by technical advisory committees during the year. Professor Tuve referred to the Committee on Research Financing and stated that it had been organized and that a representative having the title, assistant to the president, had been engaged to make the necessary contacts with the public.

The Housing Committee had selected a new Laboratory building which was to be occupied at the expiration of the present lease March 31. Another activity of the Committee on Research was participation in the International Joint Committee on Psychrometric Data which had been organized with 12 organizations from the United States, Great Britain, and Canada as members.

As an adequate goal, in order to make research meet the needs of the Society, a budget of $110,000 a year had been established for the next three years. The chairman requested cooperation of every member and friend of the Society in the research projects and stated that criticism, particularly if it led to actual technical suggestions for action, was very welcome. He urged members having ideas for research to participate in the work of the technical advisory committees.

As a means of diversifying the research program the chairman stated that the number of cooperating research institutions was being greatly increased. Plans were also under way for certain changes in the method of presenting results of research with the thought that the JOURNAL of the Society would contain more short, readable summaries, giving data and results in practical form, the complete papers being published only in the TRANSACTIONS of the Society. Consideration was being given to research bulletins on major projects and the publication of news about research programs. Professor Tuve expressed his appreciation of the cooperation which the Committee on Research had received from the technical advisory and sub-committees during his two-year chairmanship of the committee. He also spoke of the cooperation which he had received from the Research Laboratory staff and from the Society headquarters office. In turning over his duties to the new chairman of the committee, L. P. Saunders, Lockport, N. Y., Professor Tuve expressed his belief that the research program would be very actively promoted by the new chairman, who had a long record of success in research work.

President Winslow paid a tribute to Professor Tuve for the results which he had accomplished during a most difficult period, in having established an adequate Laboratory, a plan for financing, and a comprehensive research program.

Dr. Winslow invited Cyril Tasker, Cleveland, Ohio, Director of Research, to introduce the three research papers which were being presented by the Laboratory staff. Mr. Tasker stated that during the war years the Research Laboratory and the Bureau of Ships of the Navy Department cooperated in a number of studies from 1940 through 1943. Until recently much of the information obtained was not available for general publication, but since the Navy Department had now released reports of the work with the understanding that they should be made public, three papers were being presented to the Society at this meeting.

Mr. Tasker mentioned that the complete reports were very extensive and, due to their length and the expense of preparing them, they would be available for sale in limited number at the Laboratory. The reports presented at the meeting were, therefore, summaries of the work done. Mr. Tasker stated that the paper, Effect of Branch Take-Off Design on Noise in Ventilating Duct Systems, by Oscar Imalis, F. C. Houghten, and C. M. Humphreys (to be published in April 1946 JOURNAL SECTION, *Heating, Piping & Air Conditioning*) was prepared by Dr. Houghten and Dr. Imalis at the Pittsburgh Laboratory and summarized by Mr. Humphreys, who presented the paper which was open for discussion.

Meyer Faktor, Chicago, Ill., inquired about the effect of lining duct with an insulating material which would act as a sound absorber. Dr. Imalis replied that attempts to line the duct had not been successful because the noise was created by small turbulent motion of the air and that the greatest noise was obtained at frequencies of 50 to 150 cycles. A box type sound absorber placed between the fan and the damper was not effective because the sound was created by the turbulence due to the sharp edges of the damper. In order to prove that the main source of sound was caused by turbulence of the air, the authors had fastened a plastic ridge in one of the cylinders and had found that this ridge increased the noise by 15 or 20 decibels.

B. M. Brod, Jackson Heights, N. Y., inquired whether the difficulty in eliminating the noise by sound absorbers of porous materials was not due to the low frequency noise. He stated that best results in reducing noise with sound absorbers were obtained with high frequencies, whereas the best absorbers for low frequencies were heavyweight materials, which were not practical for use in duct systems.

Mr. Tasker pointed out that the location of the microphone with regard to the equipment under test was not standardized and therefore it would be extremely difficult to compare results with the results of tests of other investigators. It was, therefore, obvious that some universally accepted standards for noise testing should be devised so as to correlate the results of investigations made by various workers in the field of sound measurement. The Laboratory had received an assignment of such a project from the Committee on Sound Control.

The second paper, An Experimental Investigation of the Effect of Change in Atmospheric Conditions and Noise Upon Performance, by Morris S. Viteles, Ph.D., and Kinsley R. Smith, Ph.D. (published in this issue, see p. 107), represented a very careful psychological study.

The third paper, Physiological Response of Subjects Exposed to High Effective Temperatures and Elevated

Mean Radiant Temperatures, by C. M. Humphreys, Oscar Imalis, and Carl Gutberlet (published in this issue, see p. 101), was described as a paper which may have great significance in our future thinking with regard to mean radiant temperature and its effect on men within hot spaces.

Mr. Tasker stated that the fourth paper, The Shielding of Thermocouples from the Effects of Radiation, by G. V. Parmelee and R. G. Huebscher of the Laboratory staff (published in February 1946 JOURNAL SECTION, *Heating, Piping & Air Conditioning*), was a short paper illustrating the attempt of the Laboratory to make the results of small investigations available as quickly as possible to the membership. It was anticipated that by publishing the results, criticism and aid would be forthcoming from the membership and that the research program and membership would both benefit therefrom.

Dr. Viteles presented an abstract of the paper, An Experimental Investigation of the Effect of Change in Atmospheric Conditions and Noise Upon Performance. President Winslow remarked that this paper was an extremely valuable and interesting contribution not only to the practical problem in which the Navy was interested, but also to general physiological knowledge.

Mr. Brod inquired regarding the nature and frequency of the noise imposed upon the subjects and whether the response from either the physiological or psychological viewpoint was different for different frequencies of noise, that is whether high frequency was more or less annoying than low frequency noise.

Dr. Viteles stated that the tests did not cover the point raised by Mr. Brod since the type of noise was established by the Navy presumably to simulate that obtained aboard naval vessels. The author stated that while it had been found in the experiments that noise did not adversely affect output of work, in other experiments in which the effect was measured in terms of physiological fatigue or CO_2 output, it was found that subjects used more effort to produce the same results under high noise conditions. The author was therefore not certain whether the effects would have been the same if judged by other measures of physiological effects rather than by output alone.

W. L. Fleisher, New York, N. Y., referred to the interest which the Society had in the subject because it was a basic subject that started at the Society's Research Laboratory. He pointed out that the relationship between the dry-bulb temperature and the wet-bulb temperature which produced the effective temperature was of fundamental importance. He stated that as there may be a great variation in the relationship of sensible and latent heat for any new effective temperature, it was important to know whether the 80 to 75 deg effective temperature at which the subjects seemed to be able to perform with equal ability was at 90 or 95 deg sensible temperature level, or whether it was nearer 80 F dry-bulb temperature which would require saturation for an effective temperature of 80 F.

C. S. Leopold, Philadelphia, Pa., emphasized the point that the experiments had been conducted under conditions providing the subjects with extremely high incentives and he therefore felt that caution would be necessary in applying the same reasoning to average or low incentive jobs.

J. P. Band, Ottawa, Canada, inquired whether any information was available on the results of tests obtained from subjects working under the same conditions for periods of two months or more prior to taking the tests. He pointed out that acclimatization has a distinct effect, particularly upon work in hot climates.

R. F. Rea, Chicago, Ill., inquired whether it was possible to correlate results at the end of the test period when the subjects had increased in proficiency as well as at the beginning when they were learning to do their tasks.

Dr. Viteles, in replying to Mr. Fleisher, stated that the temperatures were obtained as follows: 73 deg ET from 80 F dry-bulb and 65.5 wet-bulb temperatures; 80 deg ET from 88 F dry-bulb and 73.3 F wet-bulb temperatures; 87 deg ET from 98 F dry-bulb and 81.5 F wet-bulb temperature; and 94 deg ET from 108½ F dry-bulb and 90.3 F wet-bulb temperature. He agreed with Mr. Fleisher that a complete investigation should cover the entire range of humidities and the entire range of conditions which produce given effective temperatures. The conditions selected in the tests were prescribed by the Navy.

Answering Mr. Leopold, Dr. Viteles stated that if he were conducting another series of tests he would not be inclined to use the same kind of incentive which was used in the tests reported. It seemed possible that the high incentive was rather unrealistic for subjects in the Navy.

Dr. Viteles stated that, since the tests were conducted in the late winter and early spring of 1940 in Pittsburgh, the subjects when not being used in tests were in a comfortable environment and were able to obtain proper rest. It is possible that the tests therefore did not represent the results which would be obtained by subjects aboard a ship in tropical waters under atmospheric conditions which would not permit the subjects to obtain proper rest. He stated that he favored the use of CO_2 output as a measure of performance.

In reply to Mr. Band's question, the author stated that under ideal conditions the types of tasks assigned to the subjects should be such as to prevent the effect of improvement. Such tests are now being planned by a committee of Army and Navy personnel and civilians. In the author's opinion this seemed like an almost impossible job because it is difficult to find any task sufficiently complex so that it would eliminate the possibility of improvement by practice. As the period of testing had been confined to 42 days, it had not been possible to conduct a sufficient number of tests to be able to compare the results in terms of change from week to week.

Mr. Humphreys presented an abstract of the third paper mentioned on physiological response of subjects exposed to high effective temperatures and elevated mean radiant temperatures.

President Winslow remarked that the test results were plotted in such a way that a progressive increase in temperature of the object being heated would be obtained by increase in the amount of heating. Such a result would be obtained in non-living materials, but would not be obtained from a human being in which the sweating mechanism would begin to cool the body when the body temperature would tend to rise. This temperature regulating effect would cause the curves to flatten out at the same extreme conditions. Dr. Winslow suggested that it would be desirable to repeat the tests on the basis of operative temperature with a known air movement and to plot the results on the basis of operative temperature which would represent the net effect of air temperature, air movement, and mean radiant temperature.

Mr. Fleisher stated that for the last seven or eight years he had contended that final temperatures rather than rise in temperatures should be used in developing the curves. He stated that he had seen some of the charts on which according to the curves dangerous conditions existed, causing the removal of a subject because of a rise in temperature, but he had found that in several cases the temperature of the subject removed was no higher than that of the subjects who remained in the test room. The difference was due to the original temperature of the subject which varied more than the particular rise which required the removal of the subject from the experiment.

He noted a variation in original temperature of the subjects from 98 to 99.2 F and consequently this represented a 1½ deg greater temperature in the lowest temperature subject when he was removed. Mr. Fleisher stated that the important thing was the final temperature of the subject and the relation of the final temperatures of the various subjects to each other, rather than the particular rise. The ambient room temperature should actually under normal conditions give an even temperature to those

who remained in the room and he believed that this would be found true if the final temperatures of the subjects had been obtained.

President Winslow agreed that Mr. Fleisher's point was well taken.

L. T. Avery, Cleveland, Ohio, stated that it was necessary to find some better measurement rather than temperature rise of the individual to determine what was actually happening to the individual working under hot conditions. He pointed out that people working in industry from the early hot days of May and then continuing progressively through the terrific heat of a foundry in July were being affected by other things than temperature rise which in some cases caused them to break down under the strain.

Professor Hutchinson agreed with Dr. Winslow that operative temperature rather than effective temperature should have been used in correlating experimental work. He believed that effective temperature was intended primarily as a heat balance correlation and therefore questioned whether 80 deg effective temperature had any other meaning except to represent a particular combination of dry- and wet-bulb temperatures.

Mr. Tasker remarked that effective temperature lines are lines of equal comfort. Effective temperature lines representing equal comfort were established under conditions in which the surrounding surfaces were about the same as the ambient temperature. It was doubtful in his opinion whether the effective temperature charts were applied to conditions where the surrounding surfaces varied to any serious extent from the ambient temperature. He stated that plans had been made to construct in the new Research Laboratory two psychrometric rooms placed side by side with easy access from one to the other for the purpose of studying the effect of mean radiant temperature on the lines of equal comfort.

President Winslow agreed with Mr. Tasker that an analysis should be made of the facts now well established to determine what the actual heat demand of a given environment would be. He stated that formulas had been worked out and thoroughly established from which could be obtained an exact determination of the heat demand of the environment from the human body if the air temperature, air movement, humidity, and mean radiant temperature were known. The heat demand, he stated, cannot be determined by the rectal temperature because of the fact that the human body adapts itself to extreme conditions and prevents the temperature from rising. Results of tests therefore do not have much significance unless all the factors are known, including the sweat loss from the individual during the experiment and including the air movement and other factors.

Mr. Humphreys, replying to Mr. Fleisher, stated that the charts were based on final temperature rather than a rise in temperature of the individual.

Referring to Mr. Avery's comments, he agreed that other things besides temperature rise were affecting the subjects as some of them had to be removed not because of the high temperature or of the pulse rate, but because of exhaustion. While their pulse and temperature were not sufficient to cause their rejection, they were still unable to remain within the room. Mr. Humphreys stated that the sweat loss had been determined and was reported in the complete paper, but was not mentioned in the presentation. In closing, Mr. Humphreys remarked that it was difficult to obtain a 40 deg mean radiant temperature elevation. In the tests conducted it was found that a 7½ ton compressor was not sufficient to provide the refrigeration necessary to maintain the required dry-bulb temperature with MRT elevation of 40 deg.

The fourth and final technical paper on the shielding of thermocouples from the effects of radiation was presented in abstract by Mr. Parmelee.

Dr. Winslow remarked that, in working with a room lined with aluminum foil for the purpose of obtaining extreme radiant effects, thermocouples attached to the wall showed a similar result varying about 2 deg. A thermocouple does not give the exact temperature of the surface, but rather something between the true temperature of the surface and the temperature of the air. In an extreme case in a room with aluminum walls and ceiling heated by reflected radiation heat from aluminum surfaces, Dr. Winslow had found that the thermal bar temperature normally considered the most accurate was approximately 20 deg higher than the temperature obtained by a thermocouple. The 20 deg difference represented the reflective effect of the aluminum surfaces. In order to obtain a true surface temperature, it was therefore necessary to use a shielded thermocouple.

C. M. Ashley, Syracuse, N. Y., stated that the paper called attention to a most important subject of laboratory technique which was often overlooked. In recent tests which he had conducted the temperature due to radiant effects was 10 deg above the actual temperature. He emphasized that the paper was definitely limited in scope and that interpretation of the shielding effects applied only under the conditions of the test. Under forced convection conditions, quite different shielding results would give optimum conditions. Mr. Ashley expressed the preference for the aspirating type of thermocouple in preference to a shielded thermocouple, since obviously the errors to be expected would be less. He also questioned whether there might not be some error in the measurement of the true air temperature under the conditions of test.

Dr. Imalis asked how the true temperature was measured.

Professor Hutchinson complimented Mr. Tasker on submitting a paper devoted to thermocouple measurements, so that the information could be found under *thermocouples* rather than in the report of some test in which they had been used.

M. K. Fahnestock, Urbana, Ill., referred to a method of obtaining a true temperature by means of thermocouples which had been successfully used in furnace testing. In this method three couples, for example, of different sizes of wires would obtain temperatures varying with the size of the couples. By plotting temperatures indicated against the equivalent diameters of the couples and then projecting the curve at intersection with the zero diameter line, the true air temperature would be obtained. This method in certain types of testing would be less difficult than would be any attempt to shield the couple. Professor Fahnestock stated that even in aspirating and forced circulation type of couples, there was still an error in the air temperature due to radiation from the shield.

Mr. Tasker thanked Professor Hutchinson for emphasizing the value of short papers which the Laboratory proposed to issue on the subject of testing methods.

Mr. Parmelee in replying to Dr. Imalis stated that the temperature of the room was not measured but that the air temperature was obtained by means of a thermocouple located within a small thermos bottle into which the air from the room was drawn. Referring to Mr. Ashley's comment that under forced convection conditions the best shielding construction might not be the same as that used in the experiment, Mr. Parmelee stated that he was not certain whether shielding would be necessary if the thermocouple were placed in a high velocity air current. It had been found in the test that when the unshielded thermocouple was placed in the room readings on the galvanometer were not stable. Apparently very small air currents were able to cause the thermocouple to register a temperature quite close to the true air temperature.

The procedure advocated by Professor Fahnestock was not used because the number of readings to be taken was so large that it was necessary to reduce the number of thermocouples as much as possible.

Dr. Winslow made an announcement regarding the loss of members during the past year by death and referred to Mrs. Olive E. Frank, who died on January 28 and stated that the Council had adopted appropriate resolutions of condolence.

President Winslow announced that Prof. Clyde A. McKeeman, formerly of Case Scientific School, would

ASHVE Members and Ladies at Statue of Liberty Bedloe's Island, N. Y.

Photo by J. C. Templeton, Jr., Marietta, Ga.

start on February 1 as assistant to the president of the Society and would direct the fund raising for research.

The president called for unfinished business and, as there was none, the meeting was declared open for new business.

B. M. Woods, Berkeley, Calif., referred to the Amendments to the Constitution and By-Laws which had been passed at the first session on January 28. He stated that the new *Section* 3 of **Article B-XI** specified procedure under which it was possible for the Society through its Council to invest funds from the endowment account in other than specified groups of securities. In order to purchase the laboratory, it would be necessary to withdraw funds from the investment account and permission to do so must be obtained by a vote of the membership after following the required 30 days notice. Such a vote could probably not be taken before the Semi-Annual meeting in June. Dr. Woods had prepared the necessary resolution for presentation to the Society and requested that all of the members who were interested should sign the resolution, although the signatures of only 10 were actually required.

President Winslow stated that his attention had been directed to an important research project in the Society's field of interest which was under way at one of the universities. He suggested that any member having such a project in mind confer with Professor McKeeman in order that the Society might take its proper part in such a research program.

C. E. Price, Chicago, presented the report of the Committee on Resolutions and moved the adoption of the following resolutions:

Resolutions

WHEREAS, the splendid success of the 52nd Annual Meeting of the ASHVE has been due to the careful and thorough preparations of New York Chapter through its Committee on Arrangements under the able leadership of its chairman, R. H. Carpenter, and of H. J. Ryan, president of the chapter, and

WHEREAS, many organizations and individuals have participated in activities providing members and guests with opportunities for entertainment, inspection and instruction.

BE IT RESOLVED THAT an expression of appreciation be adopted and that copies be sent to each of the following:

To R. H. Carpenter, chairman of the Committee on Arrangements and to his several committee chairmen and their ladies,

To H. J. Ryan, President of New York Chapter, ASHVE,

To the authors for the interesting papers presented at the technical sessions,

To W. H. Driscoll, the banquet toastmaster,

To Harvey Wiley Corbett, the speaker at the Get-together Luncheon,

To The National Broadcasting Co. for tickets to radio broadcasts,

To The Columbia Broadcasting Co. for tickets to radio broadcasts,

To The Roxy Theater for complimentary theater tickets.

To Sheffield Farms Co., Inc., for the opportunity to inspect milk processing in a modern dairy,

To the Metropolitan Life Insurance Co. for the opportunity to inspect the mechanical equipment of a large air conditioned building,

To the management and staff of the Commodore Hotel for their courtesy and service,

To the newspapers and trade papers for their coverage of the 52nd Annual Meeting.

The motion was seconded by W. T. Jones, Boston, and was passed unanimously.

Installation of Officers

President Winslow announced that the next item of business was the installation of officers and requested that W. T. Jones, past president, conduct the ceremonies. Mr. Jones stated that Dr. Winslow, while occupying the office of president, had won the esteem and respect of the entire membership by his keen mind, his fairness as a presiding officer, and his outstanding ability.

After Past President W. L. Fleisher had escorted President-elect A. J. Offner to the platform, Mr. Jones installed Mr. Offner in the office of president. He referred to his pleasant association with Mr. Offner in Society activities and the friendship which had resulted from this association. In accepting the office of president, Mr. Offner mentioned that his first appointment on a national Society committee was on the Admission and Advancement Committee by appointment of Mr. Jones, who was president at that time. Mr. Offner expressed his gratitude for the honor and his pleasure in being associated with the fine set of officers which had been elected.

Past President M. F. Blankin and Past President S. H. Downs escorted 1st Vice-President-elect B. M. Woods to the platform and Mr. Downs proceeded with the installation of Dr. Woods as first vice-president. Mr. Downs in installing Dr. Woods stated that the Society had observed Dr. Woods' abilities in the technical field as well as administrative work. He referred to the long trips which Dr. Woods had made across the continent in order to attend meetings regularly, and stated that Dr. Woods had worked very assiduously on all committees of which he had been a member.

In accepting the office Dr. Woods stated that the So-

ciety was unusual in its phenomenal interest in research and he expressed the opinion that this interesting research was the cause of the devotion which so many members felt toward the Society.

Past President Downs and Past President Blankin escorted 2nd Vice-President-elect G. L. Tuve to the platform. Mr. Blankin installed Professor Tuve as second vice-president and in so doing referred to his long and continued service to the Society. Professor Tuve expressed his appreciation of the honor of being associated with the newly elected officers and friends in the Society.

Past Presidents Fleisher and Driscoll escorted Treasurer-elect John F. Collins, Jr., Pittsburgh, Pa., to the platform. Mr. Driscoll installed Mr. Collins and mentioned his service on the Council of the Society. He spoke of the economic cycles affecting business and the Society and emphasized the fact that it is the duty of the treasurer to safeguard the funds of the ASHVE.

Mr. Collins accepted the office and expressed his appreciation of the honor of being elected treasurer.

Mr. Jones then spoke of the newly elected members of the Council who had not served previously. He asked Mr. Fleisher to instruct them in their duties and requested Past President Blankin to escort the following members of the Council-elect to the platform: E. G. Carrier, Boston; F. W. Hutchinson, Lafayette; R. A. Sherman, Columbus, and M. S. Wunderlich, St. Paul. The new members of the Council were thereupon installed by Mr. Fleisher.

Mr. Jones then presented the new group of Society officers for the ensuing year and declared them duly installed, after which he turned the gavel over to President Offner.

President Offner assumed the chair and, as his first official act, declared the 52nd Annual Meeting of the Society adjourned.

The meeting was adjourned at 12:00 noon.

Committee on Research
Three-Year Term

L. G. Miller, Head, Mechanical Engineering Department, Michigan State College, East Lansing, Mich., was born at Ankeny, Ia., February 20, 1889, and attended North High School, Des Moines. Professor Miller received his B.S. and B.S.E.E. degrees in 1913 and 1915 from Highland Park College, Des Moines, and from the

L. G. Miller
East Lansing, Mich.

Massachusetts Institute of Technology. Following his graduation he specialized in graduate work at Michigan State College.

From 1918 to 1923 he was associate professor in mechanical engineering at the University of Wisconsin, and from 1923 to 1929 he was Dean of the College of Engineering at Des Moines University. In 1929 he joined the staff of Michigan State College as associate professor, and later became acting head of the mechanical engineering department. Professor Miller, while acting head, gave courses in heating and ventilating, and was in charge of the heating and ventilating laboratory, and director of the heating and ventilating short course.

Since joining the Society in 1933, Professor Miller has taken an active interest in the affairs of the Western Michigan Chapter, serving as its vice-president and president. He has also served as a member of the Society's Council, and on various research Technical Advisory Committees.

Besides being a member of the ASHVE he is also a member of the *American Society of Mechanical Engineers* and the Lansing Engineers Club.

WILLIAMS, GRITTON & WILDE FORM PARTNERSHIP

Announcement has been made of the retirement of Henry G. Richardson from partnership in the firm, Williams & Richardson, due to ill health, after 27 years of continuous association. The name of the new partnership, effective March 1, 1946, is Williams, Gritton & Wilde, with offices at 204 Dooly Building, Salt Lake City, Utah.

Mr. Richardson, a member of the Society since 1934, served as the first president of the Utah Chapter.

Earl V. Gritton and Dale R. Wilde, also members of the ASHVE, have acquired Mr. Richardson's partnership interest, and G. W. Williams has divided his interest with his son, Major Richard C. Williams, now on terminal leave from the U. S. Army.

Mr. Gritton has been associated with the firm for 19 years. During the war he served as mechanical engineer for the U. S. Engineers. Mr. Wilde has been associated with the firm for 10 years, and during the war supervised much of the sales and engineering activity in connection with the major Army and Navy projects in the intermountain territory. Major Williams was identified with the engineering and sales departments of the Fisher Governor Co., Marshalltown, Ia., prior to 1941.

Williams, Gritton & Wilde will specialize in the design and application of heating, ventilating and power plant equipment, air conditioning systems, and building specialties.

CAPT. STACEY AWARDED F. PAUL ANDERSON MEDAL

At the 52nd Annual Meeting of the Society, January 29, 1946, Capt. A. E. Stacey, Jr., U.S.N.R., Essex Fells, N. J., received the F. Paul Anderson Gold Medal, awarded by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, for distinguished scientific achievement. The presentation was made by Dr. Willis H. Carrier, Syracuse, N. Y.

The Committee on Award honored Captain Stacey for his outstanding contributions to the advancement of heating, ventilating and air conditioning.

Before entering the Navy, Captain Stacey was vice-president of Buensod-Stacey Air Conditioning, Inc., New York, and prior to that time had been chief engineer of the Carrier Corporation. His work in the heating, ventilating and air conditioning field covered research and development in many industrial fields involving heating, air conditioning and drying.

Captain Stacey was born in Elbridge, New York, and received his degree of M.E. in 1906 from Syracuse University. He has been a member of the ASHVE since 1914. He is also a member of the *American Society of Naval Engineers, American Society for Testing Materials, Acoustical Society of America, American Association for Advancement of Science,* and many other scientific groups. He was a member of the Council of the ASHVE and served on its Committee on Research for many years and was chairman in 1940 and 1941.

He is the author of many papers and reports in scientific journals in the chemical, ceramic, and textile engineering fields.

During his naval service, Captain Stacey made contributions to the improvement and design of naval vessels of such importance that the military effectiveness of certain classes of vessels, including submarines in particular, was materially increased.

Previous recipients of the F. Paul Anderson Medal were: Dr. W. H. Carrier (1932), Dr. A. C. Willard (1936), Prof. F. B. Rowley (1939), Dr. F. E. Giesecke (1942), and Commander F. C. Houghten (1944).

The F. Paul Anderson Committee on Award for 1945 consisted of A. J. Offner, *Chairman*; W. H. Carrier, F. E. Giesecke, W. L. Fleisher and F. B. Rowley. This award was created in 1931 by the late Thornton Lewis in honor of the late F. Paul Anderson, who served as President of the Society in 1927, was former director of the Society's Research Laboratory, and Dean of the College of Engineering, University of Kentucky.

McKEEMAN JOINS ASHVE STAFF

At the 52nd Annual Meeting of the Society in New York announcement was made of the appointment of Clyde A. McKeeman as assistant to the president of the Society. He commenced his duties on February 1st.

Mr. McKeeman will represent the Society in securing the interest and participation of industry in the Society's research activities. Mr. McKeeman is a native of Maine and graduated from the University of Maine in 1923 with a degree of B.S. in mechanical engineering. He received his M.S. degree in 1931 from Harvard University School of Engineering.

He started his engineering career with Westinghouse Electric and Manufacturing Co. and in 1926 entered the field of engineering education on the staff of Case School of Applied Science. Later he was director of the evening division and served as director of war training at Case.

C. A. McKeeman

During his entire professional career Mr. McKeeman's work has been in the heating, ventilating, air conditioning, and power plant field, and he has served as a consultant in the design of heating, ventilating, and cooling systems, and in the fields of combustion and power plant design.

He was director of supervisory training for Thompson Products Co., and subsidiaries, Cleveland, just prior to accepting his present appointment.

In 1936 Mr. McKeeman joined the Society and has taken an active part in its activities. He has served on many of its technical committees, including the Committee on Research and the Technical Advisory Committee on Removal of Atmospheric Impurities. He also served as a member of both the Chapter Delegates and Nominating Committees of the Society. He served as president, vice-president and secretary of the Northern Ohio Chapter.

Mr. McKeeman is the author of several papers which have appeared in the Society's TRANSACTIONS and in other scientific publications. He is listed in Who's Who in Engineering, and is a member of Sigma Xi and the Cleveland Engineering Society.

With his background of activity in this field and his wide acquaintance in its allied industries and his experience in public relations work, the Officers and Council are pleased that he has joined the ASHVE staff.

A Message from Norway

A long letter from Alf Tjersland, Oslo, Norway, gives a vivid description of some of the events that occurred since 1941 and some comments on present conditions in the Scandinavian countries.

Mr. Tjersland joined the Society in 1906 and indicates his earnest desire to visit the United States again after a period of over 25 years.

FIVE LONG, dreadful years have passed since I had the pleasure of receiving your letter of the 13th of May 1941 as answer to my letter of February 18 of the same year.

Nobody anticipated that this terrible war would last so long, but thanks to the active part which America played, the war was brought to a successful end.

We are all, here in Norway, greatly indebted to the late President Roosevelt for the frank and good friendship he showed Norway, especially in the way he took care of our beloved Crown-princess and her children. At that same time we are also glad that our little Norway—perhaps indirectly—with our great and modern tanker and merchant fleet, has had certain influence on the good ending of the war.

We sincerely hope that both the nazism and fascism are conquered forever, so that we again can return to the liberal democracy to the prosperity of and benefit to our people and country.

Naturally we have had our great difficulties during this dreadful occupation. Many of our nearest and best friends are killed, others have for years been in concentration camps. Many have also returned with broken health and will never recover properly. But we had the spirit to hold out and the will to regain our freedom, and this gave us the strength of this great and difficult time.

Regarding my sons, one was unfortunate enough to be wounded by a German with the result that his leg was broken. This happened only eight days before we were liberated. He is 21 years old and has acted as a leader of a patrol in the underground movement. He had to take care of all weapons and ammunition, which were dropped at different places. When the Germans gave up we had, therefore, about 40,000 well trained and well armed young men to help us to keep order and to take charge of all military establishments, etc.

Unfortunately, on account of the above mentioned accident my son had the misfortune to be in a hospital about six and one-half months. He is, however, now on the way to a good recovery.

His elder brother was also arrested on account of illegal work and was in prison for some months.

We hope soon to be able to start the rebuilding and reconstruction of our battered country. Unfortunately, it seems, however, that the spiritual stress has been quite considerable for the workmen as well as for all others. So much has happened during these terrible years that we have so far not been able to regain our balance. We hope, however, that from New Year we will come up to 100 per cent activity, and this is to a great extent due to the marvelous help which we directly and indirectly have received from friends in the U. S. A. and Great Britain.

The good-will Norwegians now enjoy throughout the world also gives us a great responsibility, so that this good-will can last and that the Norwegians always will be welcome guests and friends amongst the great nations. Also from a cultural point of view we hope that there will be more intensive and intimate cooperation.

In this connection I will mention that I am a member of the Swedish Society of Heating and Sanitary Technique (Svenska Värme och Sanitetstekniska Foreningen) and I was fortunate enough to be able to attend their annual meeting in Stockholm the 25th and 26th of October 1945. One of the Swedish engineers, Dr. Techn. J. Rydberg, spoke about a study tour to America from which he had just returned. He made a point especially of mentioning the research work in U. S. A. Our scientific works on these matters are now in keen development, and we have in our Norwegian Society of Heating and Sanitary Engineers (Norsk Sanitaer og Varmeteknisk Forening) made out a proposal for Norwegian standards for the calculation of the heating volume for buildings. I enclose a preliminary proposal which is the result of hard work by a committee, which has worked for years on this matter. This proposal has been sent to our neighboring friends, Sweden, Denmark and Finland, in order to get their cooperation.

At the same time we are working out a proposition for uniform methods of calculation for heating and sanitary plants. This committee consists of the most important technical consultants and representatives for the sanitary and heating (technical) firms, which also have in their service a great number of prominent engineers.

In my firm I have 25 qualified engineers, who are planning and working out sanitary, heating, ventilating and air conditioning plants, water works and sewage plants for towns and crowded districts, electrical power stations, etc.

Together with the proposal on Norwegian standards for the calculation of the heating volume for buildings, sponsored by the Norwegian Society of Heating and Sanitary Engineers, I send a copy from the Swedish Society of Heating and Sanitary Technique's proceedings of 1944. . . .

As I informed you in my letter of the 18th of February 1941, I have for many years hoped and looked forward to be able to take part in the 50 year jubilee of the Society, where I myself would be happy to celebrate my 40 years of membership.

Unfortunately, the commercial agreement with America has not yet been settled and on account of the difficult conditions which prevail in our country I shall not be able to obtain the necessary money-value for the journey, not even the necessary small amount for my subscription fees to the Society for the years 1940 up to 1946 is obtainable. I sent my application to Norges Bank (the National Bank of Norway) several months ago, but they regret to say that they are not able to place the necessary value at my disposal before the commercial agreement with America has been settled. I hope, therefore, that you, Mr. Hutchinson, will explain this to our treasurer. As soon as the commercial agreement has been signed I hope to be able to send you the dollar-amount as quickly as possible. . . .

Unfortunately, as I did not have the opportunity to take part at the meeting of the 50 years' jubilee in 1944, I still have a small hope that during this year I shall be able to get the opportunity to undertake a new study tour in America.

I will ask you, dear sir, to give my kindest regards to my personal friends who may still remember me, perhaps especially from my last tour in the U. S. A. in January 1920, where I had the pleasure of taking part in the Annual Meeting in New York together with my present chief engineer, Johan Karlsen.

Notre Dame Church

Courtesy of Canadian National Railways

Montreal in June

THE SEMI-ANNUAL Meeting of the Society in 1946 will be held in Montreal, Canada, in June. The Council accepted the cordial invitation of the Montreal Chapter, which will act as hosts for this meeting.

Alfred J. Offner, president of the Society, has been advised by A. B. Madden, president of the Montreal Chapter, that F. A. Hamlet will act as General Chairman of the Committee on Arrangements, Leo Garneau as Vice Chairman, and S. W. Salter, Secretary.

It is planned to have three business and technical sessions, and in advance of the sessions there will be a meeting of the Council, and a Chapter Delegates meeting. In addition to the meeting of the committee on Research there will be a number of meetings of the Technical Advisory Committees.

Special accommodations reservation forms will go out to members, and requests for rooms should be filed promptly. Train reservations should be made as soon after April 27 as possible.

Montreal is readily accessible by rail, air lines, or by good automobile roads. The city is noted as the commercial and financial capital of Canada, and has many landmarks and monuments that attest to its romantic history. Montreal combines modern building construction with the old styles of colonial days. There are many churches and cathedrals of the old French régime and visitors and members will be impressed with the curious spectacle of a modern city growing around an old-world settlement.

Montreal is located on the banks of the mighty St. Lawrence, and was founded because the Lachine Rapids prevented further navigation of the river. The city lies beneath the shadow of old Mount Royal and visitors will be thrilled with the spectacular sight of the metropolis viewed at night from the top of Mount Royal.

Members traveling by rail will reach Montreal over the two transcontinental systems, the Canadian National and Canadian Pacific, which offer through car service from the principal cities in Canada and from the United States via connecting lines.

Among the scenic spots in the city are Chateau de Ramezay, St. John's Cathedral, St. Joseph's Shrine, Notre Dame Church, Botanical Gardens, McGill University, the Art Museum and many other historic buildings and monuments.

Information concerning immigration custom regulations and additional details about the program will be sent to members.

COMMITTEE ON ARRANGEMENTS

F. A. Hamlet, *General Chairman*

Leo Garneau, *Vice-Chairman*

Banquet: A. B. Madden, J. B. Flanagan, G. L. Ballantyne.

Entertainment: T. H. Worthington, A. F. Lamontagne, Jack Wright.

Finance: F. G. Phipps, J. D. Ross, Clifford A. Booth.

Inspection: A. M. Peart, J. G. Chenevert, W. J. Orr.

Ladies: J. J. Cosgrove, A. E. Watts, F. A. Sheppard.

Publicity: W. G. Hole, E. H. Terrence, J. H. Storey.

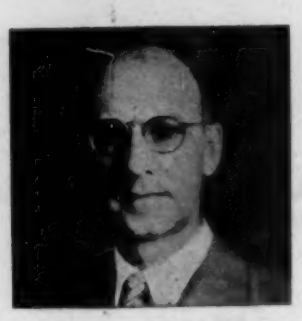
Sessions: J. B. Dykes, B. J. Horsburgh, Ralph Grossman.

Reception: W. W. Timmins, J. P. Fitzsimons, John Colford.

Secretary—S. W. Salter

A view of Montreal

Courtesy of Canadian National Railways



Prof. A. P. Kratz

PROF. KRATZ, ACTING HEAD OF M. E., UNIVERSITY OF ILLINOIS

Prof. A. P. Kratz, one of the outstanding members of the Society, has been appointed acting head of the Department of Mechanical Engineering, University of Illinois, Urbana, following the retirement of Prof. O. A. Leutwiler.

A native of Champaign, Ill., Professor Kratz was graduated from the University in 1907 with a B.S. in mechanical engineering, and in 1909 he received his M.S. degree in mechanical engineering. He joined the ASHVE in 1925, served as a member of the Council from 1938 to 1943, and has served as chairman of many of its important technical and Society committees, including Committee on Research, Publication, Meeting and several Technical Advisory Committees, as well as on the F. Paul Anderson Award Committee.

Professor Kratz is the author of numerous University of Illinois Experiment Station Bulletins and miscellaneous papers and articles on subjects dealing with flow of fluids, flow of air in ducts, gravity and forced air heating, ventilating and air conditioning, combustion and fuels, internal combustion engines and refrigerating equipment, many of which have been published from time to time in the Society's JOURNAL and TRANSACTIONS.

DR. ROSE RETURNS AFTER MONTHS ABROAD

Dr. H. J. Rose, Director of Research, Bituminous Coal Research, Inc., Pittsburgh, Pa., and a member of the ASHVE's Committee on Research, has recently completed an extensive mission in Europe for the U.S. Government. Dr. Rose's assignment in technical intelligence work took him into Germany, England, Belgium and Switzerland, where he visited coal-processing plants, fuel research laboratories, coal mines and plants of equipment manufacturers. The purpose was to obtain information on wartime developments abroad on the more efficient production and use of coal. During part of the trip Dr. Rose worked with various fuel experts of the U.S. Bureau of Mines, and many investigations in Germany were carried out in collaboration with British scientists.

These studies resulted in obtaining timely information on processes and machines for coal mining,

Dr. H. J. Rose

cleaning and drying; underground gasification; complete gasification with oxygen; high- and low-temperature coking; power generation including gas turbines; residential heating and cooking stoves; heat pumps, etc.

The detailed technical information obtained abroad is releasable only through authorized Government channels. A special section of the U.S. Bureau of Mines has been set up in Washington under L. L. Newman, to handle the compilation and correlation of the information obtained on solid, liquid, and gaseous fuels. The policy is to make the information freely available as soon as possible in the regular series of Bureau publications.

Dr. Rose served as vice-chairman of the Committee on Research in 1943 and 1944.

COMPANY ORGANIZED IN CHICAGO

H. T. Kucera has announced the organization of Automatic Devices Co., Chicago, Ill., which will specialize in the manufacture and selling of the *Weather-Man*. The Weather-Man is a fully automatic thermostatic control, actuated by outside temperatures for controlling the heating of a building.

H. T. Kucera

Mr. Kucera, President of Automatic Devices, is the inventor of the temperature control devices, and until July 1945, he was vice president of the Marsh Tritrol Co. in charge of sales and distribution of Marsh regulators. He spent the past 16 years in the development and sale of *outside* type building heat controls, developing the automatic *programming* of building heating.

He was one of the organizers and members of the Fuel Conservation Council for War, Automatic Controls Industry and a member of the Temperature and Combustion Control Industry advisory committee to the War Production Board.

He is also a member of the Illinois Chapter, ASHVE.

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FRANK HECHT DIES SUDDENLY

It is with a deep feeling of regret that the Society announces the sudden death of Frank Henry Hecht, Pittsburgh, Pa. He died in his office, of a heart attack, on Saturday, January 26, 1946.

Mr. Hecht was born at Philadelphia, Pa., May 31, 1881. He graduated from the Manual Training High School in Philadelphia. He was the representative for the B. F. Sturtevant Co. for approximately 46 years, in Philadelphia, Boston, Duluth, and Pittsburgh. He was well thought of as an engineer and especially well qualified in the designing of heating and ventilating systems as borne out by the outstanding work he had accomplished.

He joined ASHVE in 1930, and took an active interest in the activities of the Pittsburgh Chapter.

He is survived by one son and one daughter to whom the Officers and Council extend their heartfelt sympathy.

WALTER KLIE DIES IN CLEVELAND

It was with deep regret that Society members learned of the death of Walter Klie, following an operation, February 12, 1946, in his 65th year.

Mr. Klie was born at Columbus, Ohio, where he obtained his education. He was graduated from the Department of Mechanical Engineering, Ohio State University.

He began his career in industry with the Westinghouse Electric and

Walter Klie

Manufacturing Co. in 1904, and for the next two years was engaged in his own business in Columbus, Ohio. From 1906 to 1913 he was in New York as sales engineer for the J. L. Mott Iron Works. In 1914 he went to Cleveland as President of the Smith & Oby Co., a position that made his name prominent in the contracting field all over the country.

He was President, for three terms, of the *Heating, Piping and Air Conditioning Contractors National Association,* served as a member of its Board of Directors and took an active part in all of the work of the association.

He was also very active in civic and community affairs and served on many committees. He was a member of the budget and policy committees of the Welfare Federation in Cleveland; the Cleveland Rotary Club; President of the Builders Exchange; Chairman of the post-war planning committee for the construction industry of the Cleveland area; Chairman of the division for action in the construction industry of the Committee of Economic Development and many others.

Mr. Klie had been a member of the ASHVE since 1915, had served on some of the committees and had just recently been elected to Life Membership in the Society.

The Officers and Council of the Society will miss him greatly and extend their sincere and heartfelt sympathy to his family, his wife and two children; a brother, Robert Klie of Columbus, and four grandchildren; and to his many friends.

R. J. P. LEINBERGER DROWNED IN LINE OF DUTY

Word has just been received of the death of Richard J. P. Leinberger, F2/C USN, on September 11, 1945, while in line of duty to his country. His burial took place in Manila.

Young Leinberger was born in Muscatine, Ia., May 28, 1915. He attended the Boys' Technical High School at Milwaukee, the Milwaukee Vocational School and the Extension Division of the University of Wisconsin. He was a young man of excellent personality. In 1935 he started as engineering apprentice with the Pflugradt Co., Milwaukee, and in October, 1939, was given complete charge of the Engineering Department of that company. He entered the Service August, 1944.

He was elected a Junior Member of the Society in March, 1942, and at the time of his death was eligible for associate membership. He was active in the Wisconsin Chapter.

It was with deep regret that the Officers and Council learned of the death of this promising young man and their heartfelt sympathy is extended to his wife, his mother, residing at 1513 South 22nd St., Milwaukee, Wis., and sisters and brothers.

E. C. MALADY DIES IN INDIANAPOLIS

The Indiana Chapter has announced the death of Edward Charles Malady, Indianapolis, Ind., at the age of 48.

Mr. Malady was born in Chicago, Ill., May 25, 1897. He attended Northwestern University in Evanston, Ill., and the Armour Institute. He was a veteran of World War I, and a member of Sahara Grotto, American Legion. He was employed as draftsman with the H. H. Davis Co., Chicago, as engineer with Apex Ventilating-Electrical Co., Chicago, and Garwood Co., Indianapolis; for a number of years he had his own contracting business; and at the time of his death was Plant Engineer for Brad Snodgrass, Inc.

He was a member of the Capitol City Masonic Lodge, F. and A. M. and of the Indianapolis Air Conditioning Council. Mr. Malady joined the ASHVE, Indiana Chapter in 1944, when he became a member of the Society.

The Officers and Council extend their deepest sympathy to his father, in Chicago, his widow, Mrs. Mabel L. Malady, who resides at 3515 North Pennsylvania Street, Indianapolis, Indiana; and to his two sisters, both of Chicago.

L. A. STEPHENSON, OF KANSAS CITY, DIES

Lewis A. Stephenson, Sales Manager, Kansas City Office of the Powers Regulator Co., died January 23, 1946.

Mr. Stephenson was born at Redmon, Ill., September 7, 1878. He attended the Preparatory School of the University of Illinois, and obtained his B.S.M.E. from the Department of Mechanical Engineering of that University.

L. A. Stephenson

He began his career as apprentice machinist in the Illinois Central Railroad shops at Chicago and later was employed with the Powers Regulator Co. From 1906 to the time of his passing he was employed as the Kansas City representative of that company, where he was engaged in the sale and installation of automatic temperature controlling apparatus. During World War I he was Captain of the Ordnance Department, U. S. Army.

Mr. Stephenson had been a member of the ASHVE since December, 1917 and the Officers and Council of the Society extend their deepest sympathy to his family and friends.

SUMMARY OF LOCAL CHAPTER MEETINGS*

CENTRAL OHIO—January 21, 1946. Subject: The Carrier Conduit Weather-Master System. Speaker: H. C. Hoffmann, Chicago District Office, Carrier Corp. As a second feature of the meeting a colored sound film showing the operation and performance of the Helicopter airship was presented. Copies of the Code of Ethics of the ASHVE were distributed. Attendance, 59. Attendance ratio, 0.57.

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CONNECTICUT—January 9, 1946. Subject: Radiant Insulation. Speaker: Dr. C.-E. A. Winslow, President of ASHVE, and Director, John B. Pierce Laboratory of Hygiene, New Haven, Conn. Dr. Winslow's talk was illustrated and great interest was shown in the subject as evidenced by the number of questions and the discussion. Comdr. E. J. Rodee, first Secretary of Connecticut Chapter, was welcomed by Mr. Hart. Commander Rodee stated that he was glad to meet again with the Chapter and commented on the growth of the Chapter in the war years. Attendance, 72. Attendance ratio, 1.4.

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DELTA—January 11, 1946. This meeting represented the Chapter's Contribution to the Louisiana Engineering Society Annual Meeting. President Grant cordially welcomed the presence of the *LES* members and the many visitors. G. E. May, Engr., New Orleans Public Service, Inc., illustrated a very interesting discussion on Reverse Cycle Refrigeration. P. A. Croney showed slides and presented a commendable paper on Heating for Housing Projects. Dr. J. C. Morris, Tulane University, spoke on the Atomic Bomb Development in which he was actively engaged during the war. A rising vote of thanks was given to the speakers for a most interesting program. Attendance, 85. Attendance ratio, 2.4.

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GOLDEN GATE—January 16, 1946. Subject: Dehumidification of Naval Vessels in the Reserve Fleet. Speaker: Comdr. John Everetts, Jr. The speaker described how, by means of dehumidification of the air spaces and by coating deck equipment with a plastic film, battleships and aircraft carriers can be restored to active service in 30 days and cruisers and destroyers in about three weeks. This would insure a reserve fleet within a month after the outbreak of war. He stated that through naval research absorbents had been developed which will be of great value to industry when released. These data will be made available through the ASHVE for use of its members. Attendance, 37. Attendance ratio, 0.44.

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ILLINOIS—January 14, 1946. Subject: The Development and Performance of Radiant Baseboard Panels. Speakers: John P. Magos, Dir. of Research, Crane Co.; M. W. McRae, Research Engr., Crane Co.; and Warren Harris, Research Professor, University of Illinois. Two of the talks were illustrated by slides. The turnout for this subject broke attendance records of many years standing, for 180 members and guests gathered to hear the three speakers discuss the types of panels available, methods of installing them, and results achieved by their use in the research home at Urbana. Other features of the meeting were the presentation of Life Membership certificate in the Society to Frank P. Keeney, President of the Keeney Publishing Co., and the introduction of three new members. Attendance, 180. Attendance ratio, 1.00.

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INDIANA—February 1, 1946. Subject: Forced Circulation—Hot Water Heat. Speakers: Mr. R. A. Patterson, General Sales Manager, Bell and Gossett Co., Morton Grove, Ill., and his assistant, L. Shank. C. R. Ammerman presided in the absence of Pres. G. B. Supple. I. W. Cotton gave a short resumé of Chapter Delegate activities at the recent Annual Meeting in New York. Attendance, 66. Attendance ratio, 0.81.

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IOWA—January 15, 1946. Subject: Applied Heat Transfer. Speaker: Dr. Monte Staver, Professor of Mechanical Engineering, Iowa State College. Dr. Staver conducted a very interesting question and answer period following his talk. Attendance, 16.

IOWA—December 10, 1945. Subject: Performance of Radiant Baseboards. Speaker: Prof. W. S. Harris, University of Illinois, Urbana. The speaker invited the members to join in the discussion of this subject after his talk. Attendance, 19.

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KANSAS CITY—February 4, 1946. Subject: Developments in Lighting. Speaker: John M. Arthur, Kansas City Power & Light Co. He presented a wide variety of demonstrations and a movie giving a history of lighting and a complete story of the fluorescent light. An active question and answer period followed the talk. Four new members were introduced to the Chapter. Attendance, 41.

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MICHIGAN—February 11, 1946. Subject: Heat Transfer from Direct-Fired Heating Surfaces. Speaker: Prof. Lorin G. Miller, Head of the Department of Mechanical Engineering, Michigan State College, East Lansing, and newly elected member of the Society's Committee on Research (three-year term). A very spirited question and answer session was held at the conclusion of the talk and Professor Miller was given a rising vote of thanks. Pres. R. F. Connell reported briefly on the actions taken at the Annual Meeting held in New York. Attendance, 72. Attendance ratio, 0.61.

MICHIGAN—January 21, 1946. The Michigan Chapter members were the guests of the Detroit Edison Co. at dinner, after which they adjourned to the Auditorium for the meeting. Subject: New Things to Come. Speaker: Henry S. Walker, Dir. of Research, Detroit Edison

* Note. The attendance ratios shown represent the membership attendance divided by the chapter membership. These ratios will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by the various chapters and may be useful in deciding on subjects for chapter meetings.

Co. Additional features of the program were the showing of two films, The House of Tomorrow, which had a direct bearing on the speaker's topic of the evening, and *Laura*. At the conclusion of an exceedingly pleasant evening a rising vote of thanks was given Mr. Walker and the Detroit Edison Co. Thurlow E. Coon and Edward L. Hogan were presented with Life Membership certificates in the Society. Attendance, 120. Attendance ratio, 0.96.

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MINNESOTA—January 7, 1946. Subject: Hot Water Panel Heating, illustrated by slides. Speaker: R. E. Moore, Vice-President, the Bell & Gossett Co. After the talk Mr. Moore answered a number of questions. Two Chapter members, Robert Honey and Henry P. Roberts, recently returned from military service, and a new member, Arthur Hovda, were introduced.

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NORTH TEXAS—January 21, 1946. Subject: Two Panel Heating Systems. Speaker: Henry Martyn, President, Martyn Bros., Inc., Dallas. A lively period of discussion followed his talk. The Chapter was congratulated on having 100 per cent attendance for the year 1945. Attendance, 68. Attendance ratio, 1.2.

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NORTHERN OHIO—January 14, 1946. Subject: The Future of Hot Water Heating. Speaker: R. E. Moore, Vice-President, Bell & Gossett Co. The talk was amplified by the showing of slides. A rising vote of thanks was extended to Mr. Moore for an interesting talk. The late Walter Klie was presented with a Life Membership certificate and four new members were presented for membership in the Chapter. Attendance, 105. Attendance ratio, 0.73.

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ONTARIO—February 4, 1946. Subject: Common Sense About Radiator Heating. Speaker: Harold Day, Manager, American Radiator & Standard Sanitary Corp. Attendance, 104. Attendance ratio, 0.47.

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OREGON—January 3, 1946. A Chapter Business Meeting was held with Pres. Frank Urban presiding. A report was given by the Membership Committee, also a Financial Report by Mr. Burtchaell. Discussion followed. Attendance, 32.

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PACIFIC NORTHWEST—January 8, 1946. Subject: Weather as Affected by the Mountains. Speaker: Prof. Philip E. Church, Professor of Meteorology, University of Washington, Seattle. The subject was very well presented and the members took a very active and interested part in the discussion that followed. C. L. Goodman, Oklahoma, who plans to establish a permanent residence and business in Seattle, was welcomed to the Chapter. Attendance, 28.

PACIFIC NORTHWEST—December 11, 1945. A very interesting definition of the word *symposium* was delivered by Prof. E. O. Eastwood, past president of the Society, even though he had to go back 2500 years to help define it. Messrs. Peterson, Beggs, Griffith and Rudolph juggled the symposium very well, discussing the mutual problems and relationship of consulting engineers, contractors and materialmen. Attendance, 26.

PACIFIC NORTHWEST—November 8, 1945. Subject: The Engineer in the Post-War World. Speaker: Dr. C.-E. A. Winslow, President of ASHVE and Director, John B. Pierce Laboratory of Hygiene, New Haven, Conn. Dr. Winslow discussed some of the complex problems which will confront us in the attempt to re-construct the framework of world society. He stated that this task can only be accomplished by the application of the highest power of the human mind to what is essentially a vast engineering problem. The only answer to such a problem is intelligent and far-sighted planning. The very essence of planning is that it extends its vision through time and space. The growth of modern science makes it possible today to visualize a life of plenty for all mankind. The application of this science to create such a life is the greatest engineering challenge in human history. Attendance, 27.

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PHILADELPHIA—January 10, 1946. The business meeting was dispensed with in order to devote the entire evening to the entertainment provided for the annual banquet.

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PITTSBURGH—January 14, 1946. Speaker: Mel J. Stevenson, Consultant Engineer, Industrial Multi-vent Division, Pyle National Co. The speaker dealt with the design, which consists of three parts: *(a)* control plate and frame; *(b)* pressure displacement air valve; *(c)* the perforated plate. He then followed through the stages of development and operation of a distinctly new type and kind of outlet for an air distributing system. After the talk a discussion was had, with the aid of a handbook which was passed to every one attending. Attendance, 41. Attendance ratio, 0.48.

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ROCKY MOUNTAIN—January 9, 1946. Subject: Radiant or Panel Heating. Speaker: C. A. Hawk, Jr., Engineer, A. M. Byers Co., Pittsburgh, Pa. After a very interesting talk the meeting was opened for questions and general discussion. Attendance, 112. Attendance ratio, 1.72.

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ST. LOUIS—January 9, 1946. Subjects: Air Conditioning in Railway Cars, Details of Design and Application of Air Conditioning and Other Mechanical Equipment to Hospital Cars, Post-War Railway Cars. Speakers: Herbert D. Euwer and E. B. Carpenter, Engineering Department, American Car & Foundry Co. The talks were illustrated by showing slides. After an interesting discussion appreciation was expressed by President Oonk in behalf of the Chapter to the speakers. Attendance, 46.

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SOUTH TEXAS—January 18, 1946. Subject: New Trends in Air Conditioning Design. Speaker: Charles Kribs, Jr., Hedrick and Lindsley. The talk and discussion following were very informative and interesting. Attendance, 57.

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SOUTHERN CALIFORNIA—January 9, 1946. Subject: V-Belts as a Means of Power Transmission. Speaker: R. A. Wegener. His talk was very instructive and interesting. Leo Hungerford and Dick Farr made a joint

presentation of a motion picture projector to the chapter as a gift from them. They were given a rising vote of thanks by the members. Attendance, 65.

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UTAH—January 14, 1946. Subject: Radiant Energy. Speaker: Dr. H. T. Plumb. The speaker gave a very interesting and educational lecture. He had a great many different types of lamps and other miscellaneous apparatus which very effectively illustrated the points he desired to make. The members were very enthusiastic in their response to questions during the discussion period. Appreciation was extended to the speaker for his splendid remarks. Attendance, 17. Attendance ratio, 0.42.

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WESTERN NEW YORK—January 14, 1946. The program for the evening, handled by Herman Seelbach, Jr., was very unusual. The guests were six women and six men who have in mind, construction of post-war homes. After Mr. Seelbach requested a brief definition of all types of heating (steam-water-air-vapor) from society members, he requested the guests to state what they wanted in their post-war homes. The discussion became very lively but did not seem to lean to any one type of system. The main interest was heating comfort. Quite a discussion revolved around insufficient coordination between architect, material manufacturer, contractor and heating engineer. Attendance, 42.

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WASHINGTON, D. C.—January 9, 1946. Subject: The Nation's Fuel Supply. Speaker: Dr. Arno C. Fieldner, Chief of Fuels and Explosives Branch, U. S. Bureau of Mines. The speaker gave a very enlightening and interesting talk. Attendance, 47. Attendance ratio, 0.44.

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WISCONSIN—December 17, 1945. Subject: Technical Observations in the European Theater. Speaker: E. C. Koerper, in charge of Special Engineering for A. O. Smith Corp., formerly a Captain in the Air Technical Service Command and Consultant on the Production Service Staff of the Commanding General, Wright Field, Ohio, who has just returned from three months in England, France, Germany and Austria on a special technical mission for the Army Air Forces. The speaker gave an extremely interesting illustrated talk. An interesting discussion followed the talk and a rising vote of thanks was given to Mr. Koerper for an unusually valuable contribution to the knowledge of all of the members. Attendance, 37. Attendance ratio, 0.46.

Candidates for Membership

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advaneement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 62 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by April 15, 1946, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

ACKER, CHARLES B., Mech. Engr., Ps, U. S. Naval Air Station. PROPOSERS: W. J. McKinney, H. E. Sproull. SECONDERS: E. H. Taze, H. E. Barth.

ALLINGHAM, JOHN F., Student, University of Toronto. PROPOSERS: S. W. Savage, F. W. Stott. SECONDERS: William Philip, H. B. Jenney.

ALLONIER, OSCAR J., Mech. Engr., Cincinnati, Ohio. PROPOSERS: R. W. Sigmund, W. C. Pistler. SECONDERS: M. E. Mathewson, G. B. Houliston.

ANDERSON, WILLIAM T., JR., Research Dir., Hanovia Chemical & Manufacturing Co., Newark, N. J. PROPOSERS: W. F. Wells, J. L. Buttolph. SECONDERS: R. W. McKinley, H. C. Rentschler.

ANDREAS, CHARLES A., Product Specialist, Westinghouse Electric International Co. PROPOSERS: H. H. Koster, J. W. Booker. SECONDERS: I. R. Cummings, S. A. S. Patorno.

ATKINS, OREN H., Design Engr., United Electric Co. PROPOSERS: M. E. Phillips, E. H. McLane. SECONDERS: H. W. Presseur, J. K. Devereux.

BARFUS, LOUIS, Vice-Pres., Sarcotherm Controls, Inc. PROPOSERS: E. J. Ritchie, T. N. Adlam. SECONDERS: R. W. Cumming, F. C. Medcalf.

BLACKWELL, ALFRED H., Sales Engr., Allen Copper Coil Co. PROPOSERSS D. C. Griffin, E. H. Langdon. SECONDERS: E. F. Riley, M. W. McKinstry.

BORTMAN, ISAAC M., Owner, Perfect Air Conditioning Co. PROPOSERS: J. G. Werner, L. S. Scott.* SECONDERS: M. S. Hall, F. A. Leser.

COLOMBO, JOSEPH D., Draftsman & Estimator, Consolidated Conditioning Corp. PROPOSERS: Thomas Baker, B. B. Homes. SECONDERS: J. D. W. Robertson, L. J. Wachs.

CONNELL, LLOYD L., Tech. Director, Stoker Manufacturers Association. PROPOSERS: E. N. McDonnell, J. E. McDonnell. SECONDERS: N. W. Swanson, George La Roi.

CONWAY, RICHARD W., Sales Engr., The H. B. Smith Co., Inc. PROPOSERS: A. J. Offner, C. A. Miller. SECONDERS: S. A. S. Patorno, H. H. Bond.

COOPER, GEORGE P., Gen. Dock Supt., Empire-Hanna Coal Co., Ltd. PROPOSERS: W. H. Evans, H. R. Roth. SECONDERS: E. G. Spall, H. S. Moore. (*Advancement.*)

DAWSON, RALPH E., Chief Engr., Green Colonial Furnace Co. PROPOSERS: E. O. Olson, C. A. Wheeler. SECONDERS: D. E. Wells, W. W. Stuart.

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FURMAN, GILBERT J., Student, University of Michigan. PROPOSERS: Axel Marin, R. C. Porter. SECONDERS: R. S. Hawley, C. F. Kessler.

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HOSMAN, PAUL S., Sales Engr., Mechanical Heat & Cold, Inc. PROPOSERS: T. H. Mabley, J. N. Livermore. SECONDERS: G. D. Winans, E. E. Dubry.

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RICHARDSON, ELDON L., Dist. Mgr., Minneapolis-Honeywell Regulator Co. PROPOSERS: H. G. Richardson, E. V. Gritton. SECONDERS: D. R. Wilde, E. J. Watts.

RICKS, PHILIP G. II, Engr., Higgins Industries Inc. PROPOSERS: G. C. Kerr, L. V. Busenlener. SECONDERS: J. O. Crary, C. B. Gamble.

ROWE, CLARENCE R., Foreman, Norfolk Navy Yard. PROPOSERS: W. H. Webster, Jr., R. C. Thomas. SECONDERS: W. J. Gorsuch, Irwin Rosenberg.

RYDEN, ERIC H., Engr., C. A. Olsen Manufacturing Co. PROPOSERS: C. L. Grandstaff, E. R. Downe, SECONDERS: K. T. Davis, D. L. Taze.

STOVER, WARREN H., Dist. Mgr., Air Cond. Dept., General Electric Co. PROPOSERS: E. C. Willey, W. B. Morrison. SECONDERS: A. E. Finlay, J. P. McDermott.

STREETER, VICTOR L., Civil & Mech. Engr., Armour Research Foundation. PROPOSERS: W. W. Kennedy, C. J. Braatz. SECONDERS: V. M. Lathers, L. Griffis.*

TAIT, ANDREW, Sales Engr., Darling Brothers Ltd. PROPOSERS: H. J. Church, H. R. Roth. SECONDERS: H. B. Jenney, William Philip.

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TUCK, ROBERT G., Engr., International Sales Co. PROPOSERS: E. C. Fanning, H. V. Hickman. SECONDERS: N. H. Peterson, F. J. White.

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WRENE, NILS T., Engr., South Orange, N. J. PROPOSERS: C. S. Koehler, L. B. Belford. SECONDERS: S. Romendahl,* C. Bruer.*

WRIGHT, PAUL H., Sales Engr., Minneapolis-Honeywell Regulator Co. PROPOSERS: G. D. Maves, J. J. Johnson. SECONDERS: F. L. Adams, Fred Janssen.

* Non-Member.

Candidates Elected

In the past issues of the Journal of the Society the names of the following men were listed as Candidate for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, *Section* 8, of the By-Laws, the following list of candidates elected:

Members

COLLINS, EDWARD E., Refrig. Engr., Retail Construction Co., San Francisco, Calif.

EHLERS, WILLIAM D., Cons. Engr., Cincinnati, Ohio.

EMRICK, A. A., Chief Engr., United States Radiator Corp., Detroit, Mich.

KARTORIE, V. T., Asst. to Vice-Pres., York Corp., York, Pa. (*Advancement.*)

KENNEDY, ARTHUR M., Plbg. & Htg. Designer, R. P. Allsop, Toronto, Ont., Canada.

LENAZ, RALPH A., Cons. Engr., Runyon & Carey, Newark, N. J.

MARSH, GEORGE R., Sales Engr., C. J. Merrill, Inc., Portland, Me.

MCCOY, PHILIP W., Asst. Chief Engr., Bryant Heater Co., Cleveland, Ohio.

MOYNAN, JOSEPH S., Engr., New Orleans Public Service Inc., New Orleans, La. (*Advancement.*)

PRYKE, J. K. M., Assoc., Myers, Fuller & Addington, New York, N. Y. (*Advancement.*)

ROSS, JOHN H., Cons. Engr., Toronto, Ont., Canada.

RUSSELL, WILLIAM H., Engr., Weil & Moses, Waveland, Miss.

RYDBERG, JOHN A., Asst. Prof. of Htg. & Vent., Royal Institute of Technology, Stockholm, Sweden.

STINARD, R. L., Engr., The Trane Co., New York, N. Y. (*Reinstatement & Advancement.*)

TELLER, WILLIAM R., Dir. of Engrg. & Dvlpt., Bryant Heater Co., Cleveland, Ohio.

Associate Members

AITKEN, THOMAS, Estimator, Saver Co., Inc., Columbus, Ohio.

ARANDA, ARTURO, Engr., Institute of Inter-American Affairs, Santiago, Chile, S. A.

ASBURY, EDGAR, M., Sales Engr., Armstrong Cork Co., Houston, Tex.

BAHLER, ROBERT E., Asst. Engr., U. S. Army Engineers, Seattle, Wash.

DONOVAN, RICHARD F., Research Engr., LeTourneau Company of Georgia, Toccoa, Ga.

ESSLINGER, LOUIS A., Partner, L. J. Esslinger & Son, Detroit, Mich.

ETTER, NORMAN W. P., Htg. Engr., Enamel & Heating Products Ltd., Sackville, N. B., Canada.

HOWARD, JOSEPH R., Sales Engr., Minneapolis-Honeywell Regulator Co., Hartford, Conn.

INGLE, JOHN F., SR., Field Engr., Sterling Electric Motors Inc., Los Angeles, Calif.

JACOBSON, ABRAM D., Owner, A. D. Jacobson Plumbing & Heating Co., Kansas City, Mo.

LAMONT, JAMES F., Gen. Sales Mgr., The M. S. Little Manufacturing Co., Hartford, Conn.

LOPKER, FRANK J., Owner, Frank J. Lopker Co., Los Angeles, Calif.

MAY, J. PAUL, Sr. Engr., Curtiss-Wright Corp., Buffalo, N. Y.

REA, ROBERT F., Mgr. of Product Dvlpt., Universal Zonolite Insulation Co., Chicago, Ill.

REPINO, PHILIP A., Plant Engr., Lebanon Steel Foundry, Lebanon, Pa.

REUTLINGER, R. R., SR., Vice-Pres. & Gen. Mgr., Combustioneer Corp., Washington, D. C.

RIPLEY, ROBERT M., Factory Repr., Bell & Gossett Co., Manchester, Conn.

SCHUNDLER, HANS O., JR., Prop., Schundler Insulation Co., Madison, N. J.

SILK, WILLIAM H., Htg. Engr., Cutting & Ciresi, Cleveland, Ohio.

SWAN, DAVID, Chief Engr., Kipp-Kelly Ltd., Winnipeg, Man., Canada.

TAYLOR, FREDERICK W., Grad. Student, University of Illinois, Urbana, Ill.

TOUCEY, RICHARD M., Treas. & Sales Engr., E. R. Clement Inc., Bridgeport, Conn.

TURNER, JOHN F., Engr., Templin Equipment Co., Knoxville, Tenn.

VARELA, JACOBO A., Principal, Jacobo A. Varela, Montevideo, Uruguay, S. A.

WHEELER, B. J., Lt., U. S. Maritime Service, Vancouver, Wash.

WILSON, HERBERT H., Sales Engr., Ilg Electric Ventilating Co., Memphis, Tenn.

WILSON, JOHN D., Chief Engr., Boot & Co., Grand Rapids, Mich.

WINTERS, H. GORDON, Engr., Trane Co. of Canada, Ltd., Montreal, Que., Canada.

WOODRUFF, CHARLES S., Engr., Reg. F. Taylor, Houston, Tex.

WYNN, CARL E., Estimator, Crane Co., Memphis, Tenn.

Junior Members

ANGUS, DONALD L., Engr., H. H. Angus, Toronto, Ont., Canada.

ENDELMAN, HARRY, Engrg. Draftsman, Navy Dept., Bureau of Ships, Washington, D. C.

HORSON, WILLIAM C., JR., Estimator & Draftsman, U. S. Naval Repair Base, San Diego, Calif.

ROOSE, ROBERT W., Student, University of Illinois, Urbana, Ill.

ROYCE, ROBERT F., Student, University of Michigan, Ann Arbor, Mich. (*Advancement.*)

American Society of Heating and Ventilating Engineers

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Officers of Local Chapters

Atlanta: Organized, 1937. Headquarters, Atlanta, Ga. Meets, First Monday. President, W. J. McKinney, Rm. 714, 101 Marietta St. Bldg., Atlanta 3. Secretary, H. King McCain, 615 Trust Co. of Georgia Bldg.

Central New York: Organized, 1944. Headquarters, Syracuse, N. Y. President, C. M. Ashley, 300 S. Geddes St., Syracuse 1. Secretary, F. E. Hockensmith, 400 N. Midler Ave., Syracuse.

Central Ohio: Organized, 1944. Headquarters, Columbus, Ohio. Meets, Third Monday. President, A. W. Williams, 5 E. Long St., Rm. 808, Columbus 15. Secretary, H. R. Allonier, 101 N. High St. Columbus 15.

Cincinnati: Organized, 1932. Headquarters, Cincinnati, Ohio. Meets, Second Tuesday. President, E. J. Richard, 2137 Reading Rd., Cincinnati 2. Secretary, H. K. Jennings, 1639 Union Trust Bldg., Cincinnati 2.

Connecticut: Organized, 1940. Headquarters, New Haven, Conn. President, Stanley Hart, New Britain. Secretary, Winfield Roeder, 405 Temple St., New Haven.

Delta: Organized, 1939. Headquarters, New Orleans, La. Meets Second Tuesday. President, W. H. Grant, Jr., 209 Vincent Bldg., New Orleans 12. Secretary, J. S. Burke, 317 Baronne St., New Orleans 9.

Golden Gate: Organized, 1937. Headquarters, San Francisco, Calif. Meets, First Wednesday. President, R. B. Holland, 420 Market St., San Francisco 11. Secretary, F. W. Kolb, 598 Monadnock Bldg., San Francisco 5.

Illinois: Organized, 1906. Headquarters, Chicago, Ill. Meets, Second Monday. President, James S. Locke, 433 E. Erie St., Chicago 11. Secretary, C. M. Burnam, Jr., Room 1605, 6 N. Michigan Ave., Chicago 2.

Indiana: Organized, 1943. Headquarters, Indianapolis, Ind. Meets, Fourth Friday. President, G. B. Supple, Architects and Builders Bldg., Indianapolis. Secretary, T. R. Davis, 1311 N. Drexel Ave., Indianapolis 1.

Iowa: Organized, 1940. Headquarters, Des Moines, Ia. Meets, Second Tuesday. President, B. E. Landes, 1603 47th St., Des Moines 10. Secretary, C. A. Wheeler, 511 Fifth Ave., Des Moines.

Kansas City: Organized, 1917. Headquarters, Kansas City, Mo. Meets, First Monday. President, R. B. Mason, 2014 Wyandotte St., Kansas City. Secretary, P. C. Leffel, 316 E. 75th St., Kansas City.

Manitoba: Organized, 1935. Headquarters, Winnipeg, Man. Meets, Third Thursday. President, F. T. Ball, 324 Main St., Winnipeg. Secretary, D. S. Swain, 27 Fawcett Ave., Winnipeg.

Massachusetts: Organized, 1912. Headquarters, Boston, Mass. Meets, Third Tuesday. President, D. M. Archer, 143 Federal St., Boston 10. Secretary, A. Ehrenzeller, 23 Parklawn Rd., Boston 32.

Memphis: Organized, 1944. Headquarters, Memphis, Tenn. Meets, First Monday. President, T. J. O'Brien, 1030 Exchange Bldg., Memphis. Secretary, A. T. Bevil, 1521 Waverly Ave., Memphis 6.

Michigan: Organized, 1916. Headquarters, Detroit, Mich. Meets, First Monday after 10th of month. President, R. F. Connell, 1500 United Artists Bldg., Detroit 31. Secretary, A. E. Knibb, 1003 Maryland Ave., Detroit 30.

Minnesota: Organized, 1918. Headquarters, Minneapolis, Minn. Meets, First Monday. President, R. E. Gorgen, 2120 W. Cedar Lake Blvd. Secretary, O. L. Lilja, 5000 16th Ave. S., Minneapolis 7.

Montreal: Organized, 1936. Headquarters, Montreal, Que. Meets, Third Monday. President, A. B. Madden, 1170 Beaver Hall Sq., Montreal, Que. Secretary, S. W. Salter, 910 New Birks Bldg., Montreal, P.Q.

Nebraska: Organized, 1940. Headquarters, Omaha, Nebr. Meets, Second Tuesday. President, D. E. McCulley, 814 S. 14th St., Omaha 2. Secretary, D. D. Williams, Rm. 311, Federal Bldg., Omaha.

New York: Organized, 1911. Headquarters, New York, N. Y. Meets, Third Monday. President, H. J. Ryan, 101 Park Ave., New York 17. Secretary, Carl H. Flink, Room 3000, 51 Madison Ave., New York 10.

North Carolina: Organized, 1939. Headquarters, Durham, N. C. Meets, Quarterly. President, K. W. Selden, Jr., 701 Builders Bldg., Charlotte 2. Secretary, E. S. DeWitt, 1211 Commercial Bank Bldg., Charlotte.

North Texas: Organized, 1938. Headquarters, Dallas, Tex. Meets, Third Monday. President, E. J. Stern, 701 Burt Bldg., Dallas 1. Secretary, B. S. Foss, Jr., 401 Magnolia Bldg., Dallas 1.

Northern Ohio: Organized, 1916. Headquarters, Cleveland, Ohio. Meets, Second Monday. President, G. B. Priester, 10900 Euclid Ave., Cleveland 6. Secretary, R. L. Byers, 448 Terminal Tower, Cleveland 13.

Oklahoma: Organized, 1935. Headquarters, Oklahoma City, Okla. Meets, Second Monday. President, Earle W. Gray, Third & Harvey Sts., Oklahoma City. Secretary, G. T. Donceel, Oklahoma Natural Gas Co., Oklahoma City.

Ontario: Organized, 1922. Headquarters, Toronto, Ont. Meets, First Monday. Acting President, V. J. Jenkinson, 117 Peter St., Toronto 2B. Secretary, H. R. Roth, 57 Bloor St., W., Toronto Ont.

Oregon: Organized, 1939. Headquarters, Portland, Ore. Meets, Thursday after First Tuesday. President, F. F. Urban, 6726 S. W. Burlingame Ave., Portland. Secretary, E. R. Lokey, 1326 N. W. Glisan St., Portland 9.

Pacific Northwest: Organized, 1928. Headquarters, Seattle, Wash. Meets, Second Tuesday. President, D. C. Griffin, 717 Lloyd Bldg., Seattle 1. Secretary, C. W. Finn, 702 Lloyd Bldg., Seattle 1.

Philadelphia: Organized, 1916. Headquarters, Philadelphia, Pa. Meets, Second Thursday. President, R. D. Touton, Ninth & Columbia Ave., Philadelphia. Secretary, F. H. Buzzard, 213 S. Broad St., Philadelphia 7.

Pittsburgh: Organized, 1919. Headquarters, Pittsburgh, Pa. Meets, Second Monday. President, L. S. Maehling, 778 Country Club Dr., Pittsburgh 16. Secretary, E. H. Riesmeyer, Jr., 231-33 Water St., Pittsburgh 22.

Rocky Mountain: Organized, 1944. Headquarters, Denver, Colo. Meets, First Wednesday. President, G. D. Maves, 1550 Glencoe St., Denver 7. Secretary, Fred Janssen, 1123 W. Third Ave., Denver 9.

St. Louis: Organized, 1918. Headquarters, St. Louis, Mo. Meets, First Tuesday. President, W. J. Oonk, 4548 Red Bud Ave., St. Louis 15. Secretary, W. A. Russell, 7918 Kingsbury Blvd., Clayton 5, Mo.

South Texas: Organized, 1938. Headquarters, Houston, Tex. Meets, Third Friday. President, J. A. Walsh, P. O. Box 1773, Houston. Secretary, D. M. Mills, Gray & Crawford, Houston 3.

Southern California: Organized, 1930. Headquarters, Los Angeles, Calif. Meets, Second Wednesday. President, Marcus Kennedy, 5051 Santa Fe Ave., Los Angeles 11. Secretary, R. A. Lowe, 3744 Potomac Ave., Los Angeles 16.

Utah: Organized, 1944. Headquarters, Salt Lake City, Utah. Meets, First Wednesday. President, H. G. Richardson, 1433 Harvard Ave., Salt Lake City. Secretary, E. V. Gritton, 3470 S. 15th East St., Salt Lake City.

Washington, D. C.: Organized, 1935. Headquarters, Washington, D. C. Meets, Second Wednesday. President, W. H. Littlefield, 616 New York Ave., N. W. Secretary, J. N. Stewart, 6124-32nd Pl., N. W., Washington 15, D. C.

Western Michigan: Organized, 1931. Headquarters, Grand Rapids, Mich. Meets, Second Monday. President, H. J. Metzger, 137 E. Water St., Kalamazoo. Secretary, H. W. Wolters, 830 Staples Ave., N. W., Kalamazoo 54.

Western New York: Organized, 1919. Headquarters, Buffalo, N. Y. Meets, Second Monday. President, F. A. Moesel, 31 Main St., Buffalo 2. Secretary, E. P. Heckel, Jr., 490 Broadway, Buffalo 4.

Wisconsin: Organized, 1922. Headquarters, Milwaukee, Wis. Meets, Third Monday. President, O. A. Trostel, Route No. 2, Thiensville. Secretary, J. R. Vernon, 507 E. Michigan St., Milwaukee 2.

EQUIPMENT DEVELOPMENTS

For your convenience in obtaining more information about any of this equipment, see coupon on this page. Add the new products and companies listed here to your Directory Section which you received in your January 1946 Heating, Piping & Air Conditioning and thus keep your records of sources of supply up to date throughout the year. Single asterisk indicates equipment not listed in Directory Section; double asterisk equipment and manufacturer not listed.

Oxygen Recorder

No. 3056—An automatic, continuous analyzer for indicating and recording the oxygen content of a gaseous mixture has been developed by the Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

This instrument, which is designed for use on boiler furnaces, kilns, metallurgical furnaces, glass tanks, and chemical and petroleum processes, is said to provide graphic analysis almost instantly and to be responsive to changes of 0.05 per cent. Sustained accuracy is said to be within 0.25 per cent.

A continuous gas sample is mixed with a vaporized liquid fuel and burned on a catalyst-filament which reaches a temperature proportional to the oxygen content. The filament resistance is a function of the temperature and a simple resistance bridge is connected to a null balance electronic recorder which may be calibrated in excess air, per cent oxygen, or other desired forms.

Instrument for Measuring Wall Thickness, Liquid Level and Densities

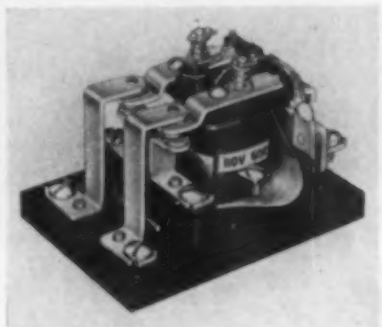
No. 3057—The "Penetron," manufactured and sold by Engineering Laboratories, Inc., 602-624 E. Fourth St., Tulsa, Okla., is an instrument which is designed to measure the thickness of any type of material, to determine the density of liquids, and to locate liquid levels.**

The operation of the unit is based upon penetrating gamma rays which are emitted from a radioactive source. In measuring the wall thickness of a pipe, for instance, a portion of the rays pass through the wall and emerge on the opposite side. Another portion of the radiation is scattered in all directions by the electrons of the atoms which make up the wall. Some of these scattered rays emerge on the same side of the wall from which they originally entered. This particular portion of the radiation, termed back-scattered radiation, is utilized in the measurement of wall thickness. By measuring the intensity of this back-scattered radiation it is possible to determine the wall thickness, since for a wall of any given composition, the intensity of this radiation increases as a direct function of the wall thickness.

The limits of thickness for which this device may be used vary with different materials. For iron or steel, wall thicknesses up to ¾ in. may be measured and for aluminum the limit is 1 in. It cannot be used for the detection of pin holes or pin hole type corrosion. According to the manufacturer, the instrument is accurate to within ±3 per cent and is ideal for many applications where the measurement or control of wall thickness, liquid level, and liquid densities is required.

Double Pole Double Throw Power Relay

No. 3058—A double pole double throw power relay (Type PR-8), which is designed for such power circuits as motor starting and heater loads up to 15 amp, or any control circuit requiring switching, has been announced by Potter & Brumfield Sales Co., Dept. 246, 549 W. Washington Blvd., Chicago 6, Ill.**



The full floating contact carriers are said to be positively locked in place and permit heavy contact pressure without chatter. A-c types are copper shaded to prevent hum. A heavy return spring provides snap action and the coil operates on approximately 3 watts. It is said to be ideal for use with thermostats or other devices with delicate contacts.

Silver contact points 5/16 in. diameter are rated at 15 amp non-inductive load at 110 volts a-c.

[*Continued on p.* 190]

Heating, Piping & Air Conditioning, [3-46]
6 N. Michigan Ave., Chicago 2, Ill.

Please ask the manufacturers to send me more information about the equipment mentioned under the following reference numbers in Equipment Developments and Recent Trade Literature.

(Circle each number in which you are interested)

3056	3057	3058	3059	3060	3061	3062	3063	3064	3065
3066	3067	3068	3069	3070	3071	3072	3073	3074	3075
3076	3077	3078	3079	3080	3081	3082	3083	3084	3085
6080	6081	6082	6083	6084	6085	6086	6087	6088	6089
6090	6091	6092	6093	6094	6095	6096	6097	6098	6099
6100	6101		6103	6104	6105	6106	6107	6108	6109
6110	6111	6112							

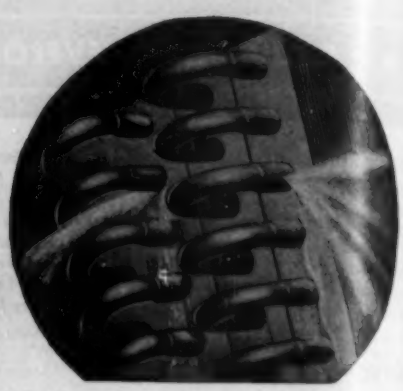
Name..... Title.....

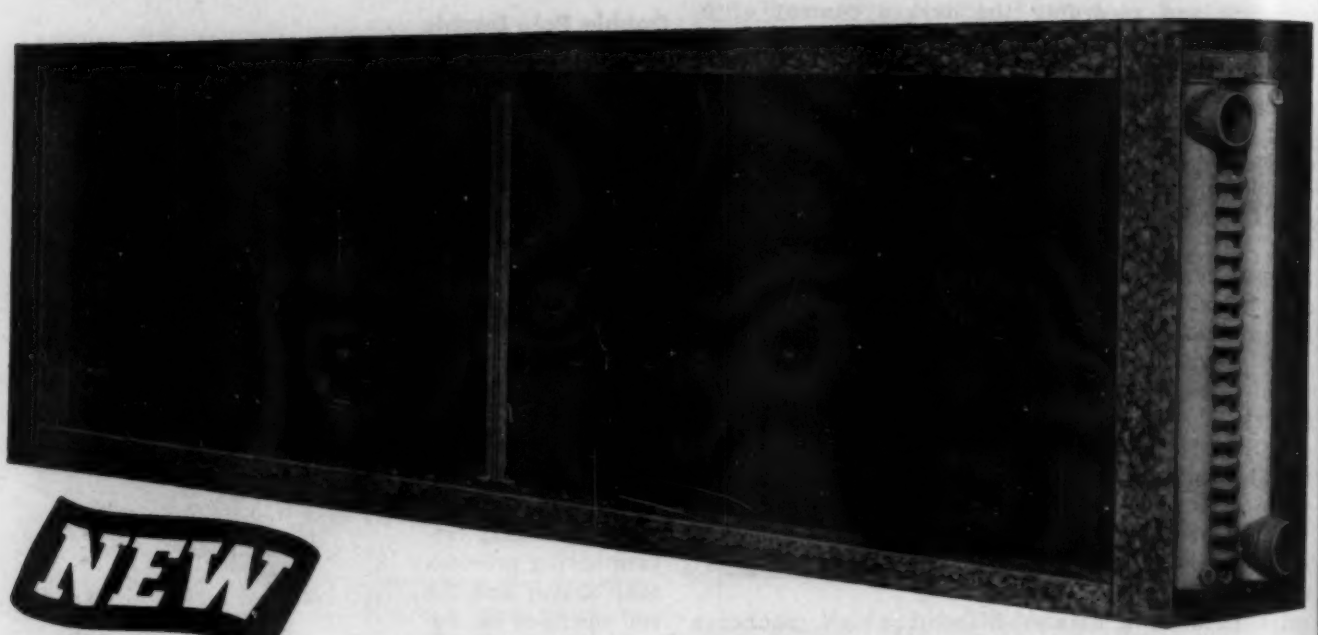
Company .....

Address .....

City.....Zone..... State.....

Protect Your Cooling Surface against Freezing!

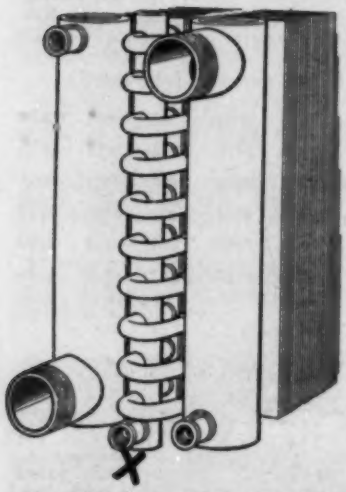




NEW

Nesbitt Water Surface

Pitched in the Casing • Exclusive Drain Feature



X marks the spot of protection — the exclusive Nesbitt Drain Feature.

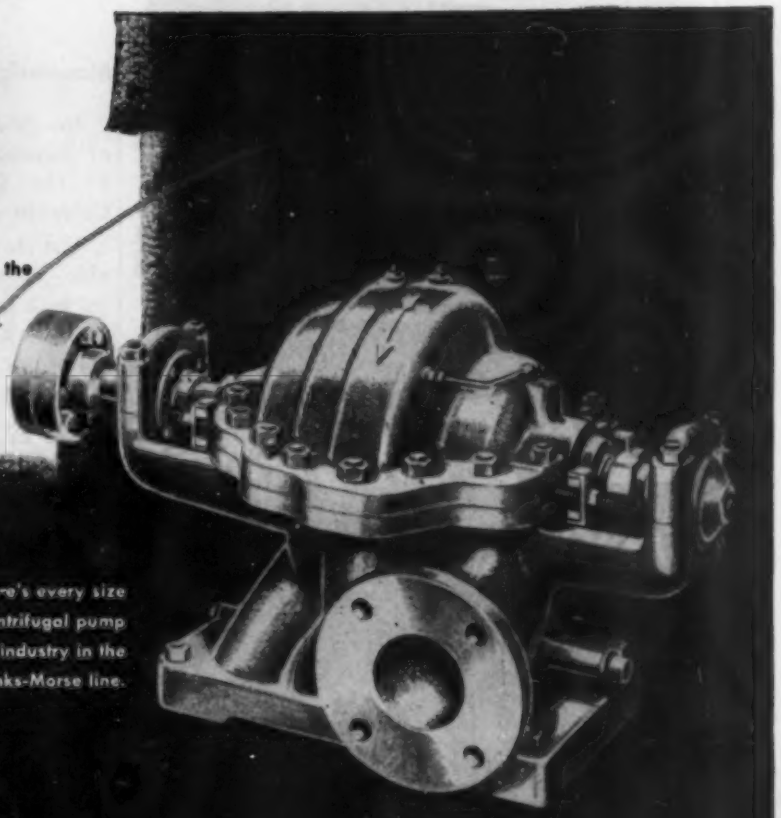
GIVE A THOUGHT to your cooling surface for this summer and prevent costly freeze-ups next winter! Continuous tube, or "serpentine" surface is good. It is compact and it eliminates expensive field manifolding. But unless some easy means of drainage is provided, the trapped water may freeze and burst the tubes in cold weather. "Self-draining" surface that presumes a perfectly level installation is only a wishful thought. The real answer is the new Nesbitt Water Surface that is pitched within its casing and has the exclusive Nesbitt Drain Feature. This permits complete drainage through the inlet, outlet and drain headers. These important Nesbitt features may save you many dollars and headaches. Investigate. Send for Publication 246.

NESBITT HEATING AND COOLING SURFACES

Made by John J. Nesbitt, Inc., State Road and Rhawn Street, Philadelphia 36, Pa.
Sold by Leading Manufacturers of Fan System Apparatus

Can ANYONE Make a Pump?

Well, there's no law against it—except perhaps the "law of survival." It's a question of what *kind* of pump you want—and how *good* you want it to be. If you want a pump that will squeeze the last fraction of a cent in value out of the monthly power bill, that is designed to the very limits of hydraulic knowledge—built with the fine tools and complete facilities that such precision design requires—you'll want a Fairbanks-Morse pump!



There's every size and type of centrifugal pump used in industry in the Fairbanks-Morse line.

Westco pumps: precision-built, broad in application.

WHEN YOU BUY a Fairbanks-Morse, Pomona or Westco pump, you get a design which is the result of accumulated years of research in not only our own laboratories but those of the universities' scientists whom we have retained!

For all vertical turbine pump work—the Pomona line.

THIS DESIGN and unlimited manufacturing facilities, which only the largest pump manufacturers can offer you, combine to give you pumps superior in performance and reliability.

ANYONE CAN MAKE A PUMP—perhaps! But for *proved* value, *skilled* service—regardless of the type of pumping requirements or the amount of liquid to be moved—Fairbanks-Morse is an unquestioned leader. Call your nearest Fairbanks-Morse distributor or branch office.

FAIRBANKS-MORSE

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DIESEL LOCOMOTIVES · DIESEL ENGINES · MAGNETOS · GENERATORS · MOTORS · PUMPS
SCALES · STOKERS · RAILROAD MOTOR CARS and STANDPIPES · FARM EQUIPMENT

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PIONEER OF THE STOKER INDUSTRY . . . ONE OF THE LEADERS IN NATIONAL SALES VOLUME!

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A COMPLETE LINE
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AGGRESSIVE PROMOTION

FREEMAN STOKER DIVISION
ILLINOIS IRON & BOLT CO.
916 S. MICHIGAN AVE., CHICAGO 5, ILLINOIS

[*Continued from p. 187*]

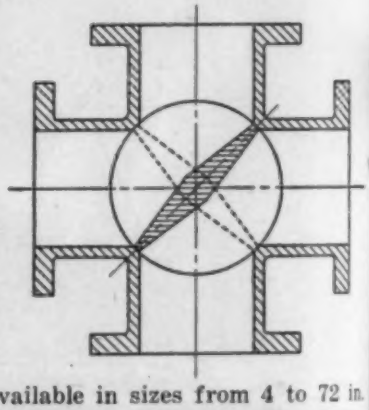
Magnetic Flow Gage

No. 3059*—A magnetic gage for indicating the flow of liquids in either direction within a pipe is offered by the Ohio Pattern Works & Foundry Co., 2735 Colerain Ave., Cincinnati 25, Ohio.

The device, available in sizes from ½ to 2 in., consists primarily of an aluminum plunger which is normally centered in a constriction of the bronze body. Phosphor bronze springs are used to center the plunger in the neutral or no flow position. Flow of liquid in either direction causes the plunger to slide on a bronze sleeve. A permanent magnet, which is attached to the plunger, causes indicator hands (on both sides of the device) to move from the neutral or no flow position and to indicate flow. The extent of the movement is dependent upon rate of flow. According to the manufacturer, any viscosity of liquid can be gaged at pressures up to 150 psi.

Four-Way Transfer Valve

No. 3060—A new 125 lb, single vane, quick operating, four-way control valve has been announced by R-S Products Corp., Germantown Ave. at Wayne Junction, Philadelphia 44, Pa.



The valve is designed for use in transferring chemicals, oils, paper pulp, sewage, water, and other materials from one line to another. It can be manually or automatically controlled and is available for use in a wide range of pressure and temperature. It is also available in sizes from 4 to 72 in. and may be fabricated from a variety of materials including "A" metal, which is said to be tough, dense, of uniform grain, and to have a high endurance limit.

Electrical Equipment Manufacturer Expands

No. 3061—The Emerson Electric Mfg. Co., St. Louis, Mo., has announced its postwar expansion program, which involves moving all manufacturing and office facilities from its downtown buildings to one of St. Louis' newest and most modern plants, located at 8100 Florissant Ave., following lease arrangements with the Reconstruction Finance Corp.

The 5-million dollar plant, on approximately 40 acres, was erected under the company's supervision for the development and manufacture of airplane gun turrets during the war.

"Columbia" Activated Carbon REMOVES Odors from Air

1 It deodorizes stale air for return to air conditioning systems.

2 It purifies intake air to remove objectionable outside odors.

3 It removes objectionable odors from exhaust air.

Installations for deodorizing air with "Columbia" Activated Carbon are supplied by a number of reputable engineering firms. Write for name and address of the supplier near you.

•

CARBIDE AND CARBON CHEMICALS CORPORATION
Unit of Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.

COLUMBIA
Activated Carbon

Life-Saver for Men and Materials

SOLVENT RECOVERY · CATALYSIS · GAS AND AIR PURIFICATION

Here's a gas boiler that *has* been improved

— in appearance, in performance

. . . and that's what your customers expect today. Completely redesigned and restyled. New, exceptionally quiet burner, many other features. Write for bulletin F-320 giving complete details.

L. J. MUELLER FURNACE COMPANY

2007 W. OKLAHOMA AVE., MILWAUKEE 7, WIS.

MUELLER Climatrol

REG. U. S. PAT. OFF.

All operations will be consolidated at this location and the entire move is scheduled for completion in September, without serious interruption of production. An enlarged program of production of electric motors, electric fans, arc welders and several new products is under way. Based on floor area, the move will mean an increase in work space of about 50 per cent, but production increases are expected to range up to 200 per cent on some products.

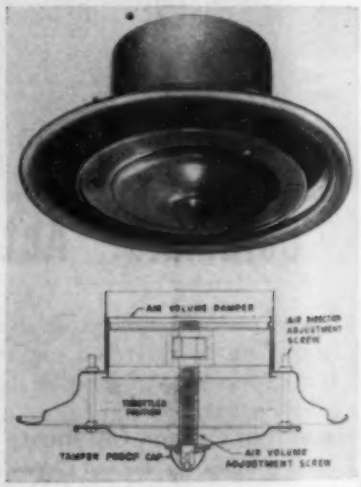
Small Solenoid Valve

No. 3062—Allied Control Valve Co., South Norwalk, Conn., has developed a new, small solenoid valve for use with water, alcohol, hydraulic fluids, air, and other media.**

Designed for pressures up to 150 psi, the valve weighs only 1 lb and requires a maximum power consumption of 10 watts. The construction features stainless steel for all parts in contact with the fluid handled, impregnated coil, and welded stem construction. The valve is of the three way, two position type designed for continuous or intermittent duty on a-c or d-c current.

Improved Air Diffuser

No. 3063—The "Kno-Draft" adjustable air diffuser, manufactured by W. B. Connor Engineering Corp., 114 E. 32nd St., New York 16, N. Y., has been modified by the addition of a tamperproof cap to the base of the damper control screw.



Centered in the lower cone, the cap must be removed with a Phillips Head screwdriver to provide access to the damper screw. These diffusers incorporate an adjustable lower cone which may be raised or lowered to vary the angle of air discharge. This feature is designed to insure uniform performance for different ceiling heights and to make it equally effective for diffusing chilled air parallel to the ceiling or delivering heated air downward.

Portable Heater

No. 3064—Surface Combustion Corp., 2375 Dorr St., Toledo 1, Ohio, reports that extensive savings in time and resultant economies for contractors working on construction jobs in cold weather are being effected by the use of the "Janitrol" portable heater.

Designed to burn gasoline, kerosene, or light fuel oil, the heater employs the "Whirling Flame" principle used in the company's line of aircraft heaters.

is an old story with amp

in the Control of Refrigerant Flow

Yes, many years ago, AMP engineers put the powerful force of the jet to work in propelling recirculated liquid refrigerant in the Kleucker patented mass flow evaporator. The result was heat absorption capacities as far beyond conventional designs as the jet plane's performance exceeds yesterday's propeller-driven models.

AMP's "jet propulsion" principles and their application to the control of refrigerant flow are especially adaptable to such applications as beer and milk cooling, food processing and freezing, sanitary industrial cooling, frosted food cabinets, and air conditioning. In many cases it improves evaporator efficiency as much as 100 per cent.

This principle, coordinated with AMP's specialized controls, brings a new concept of refrigeration technique to the industry. If you are looking for new and higher standards of compactness, efficiency, and reliability in your refrigeration operations, AMP designs will interest you. Write for information as to how our engineers can help solve *your* refrigeration problem — increase efficiency — lower costs.

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CONSERVE YOUR FUEL DOLLAR

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from your Steam Heating System

RYDAL SERVICE

RYDAL SERVICE has been scientifically developed to provide an efficient and economical method of thoroughly cleaning the interior of your heating system. RYDAL SERVICE restores the INTERNAL RESISTANCE BALANCE of your heating plant, resulting in higher operating efficiency.

RYDAL SERVICE consists of three individual treatments:—

- RIDSLUDGE thoroughly cleans all pipe lines.
- BOYLOUT cleans the boiler itself.
- PROTEX deposits a protective film throughout the heating system and retards further deposits.

RYDAL COMPOUNDS are neutrals and harmless to metals.

Ask about RYDLYME, if water scale is a problem.

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☐ We would like "CONSULTATION SERVICE" without cost in solving our cleaning problem.

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DELTA ENGINEERING LIMITED

407 McGILL ST. - - - - MONTREAL

Liquid fuel is introduced into the combustion chamber through a spray nozzle. A fan driven by a gasoline engine or an electric motor supplies the heater with air for combustion and ventilation air. Because of the relatively great heat output, it is claimed that this unit is ideal for heating buildings under construction so that work such as plastering may be carried on in cold weather.

To Manufacture Small Motors, Bearings, and Tools

No. 3065—Fractional horsepower electric motors, ball and roller bearings, electronic gages, measuring devices, and precision machine tools are among the products to be manufactured by Jack & Heintz Precision Industries, Inc., Cleveland 1, Ohio.**

According to a recent announcement, this company has been formed through the merger of Jack & Heintz, Inc., manufacturers of precision aircraft equipment during the war, with a newly formed Delaware corporation. A financial interest in the new successor company has been acquired by a group of individual investors.

Aircraft products will continue to be made and plans are under way for the acquisition of other companies and new products.

Buys Government Building

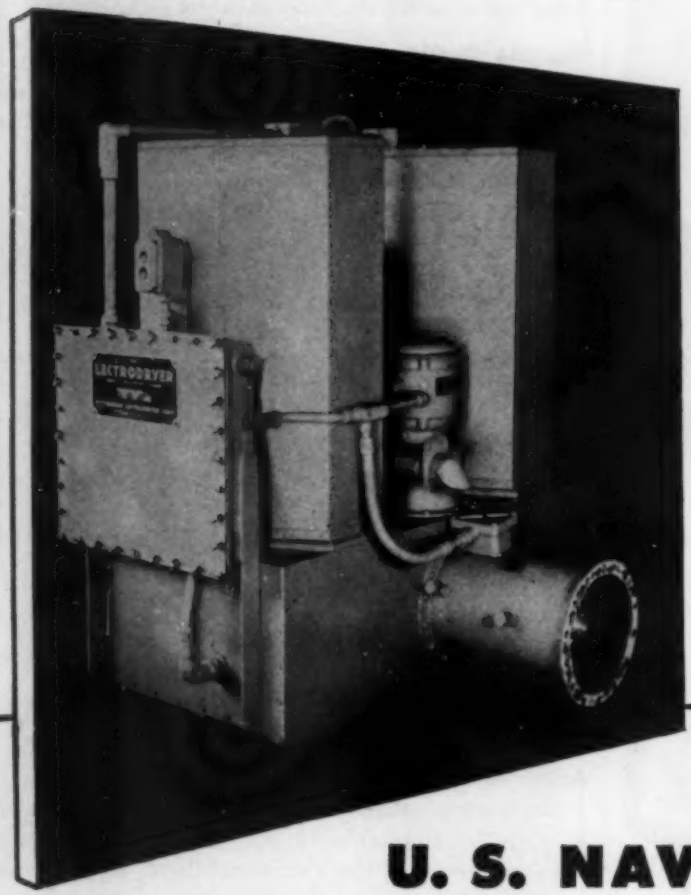
No. 3066—The Perfex Corp., 500 W. Oklahoma Ave., Milwaukee 7, Wis., has purchased the manufacturing plant which it operated during the war as its optical division.

This company, which manufactures automatic temperature controls and industrial engine radiators, and which was started in 1934, now occupies nearly five times the original plant area.

Pipe Cleaning Machine

No. 3067—A new and improved "Electro-Rod" motor-driven pipe cleaning machine has been announced by the Spartan Tool Co., 6007 N. Lincoln, Chicago 45, Ill.**

According to the manufacturer, the outstanding advantages of this unit are (1) finger tip control of the cable speed which provides for immediate disengagement of the cable without stopping the motor if the cutting blades get caught (this also makes possible rodding a line without stopping the motor), (2) with the power unit located ahead of the cable supply, there is less danger of kinking, and (3) it can be fitted with a special flexible shafting for cleaning or polishing condenser tubes, process lines, water boiler piping, etc. The unit, which may be operated



FOR SPOT DEHUMIDIFICATION

Now applied by:

U. S. NAVY FOR THE PRESERVATION OF THE RESERVE FLEET

Lectrodryers of this type and in several sizes will soon be available for many an industrial application. Prevention of corrosion, mildew or condensation; supplying dry air to process, and protection of moisture affected materials are among the multitude of uses. Compact, complete, protected, this Lectrodryer, connected to power, will work when and where you need it.

Standard Lectrodryers are available for many other needs. Air, gases and many organic liquids are dried at low or high pressures. Our engineer will welcome the opportunity of fitting Lectrodryer to your dehumidifying requirements. Write us. PITTSBURGH LECTRODRYER CORPORATION, Foot of 32nd Street, Pittsburgh 30, Pennsylvania.

In England: Birmingham Electric Furnaces, Ltd., Tyburn Rd., Erdington, Birmingham

In Australia: Birmingham Electric Furnaces, Ltd., 51 Parramatta Rd., Glebe, Sidney

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

PITTSBURGH

LECTRODRYER

Reg. U.S. Pat. Off.

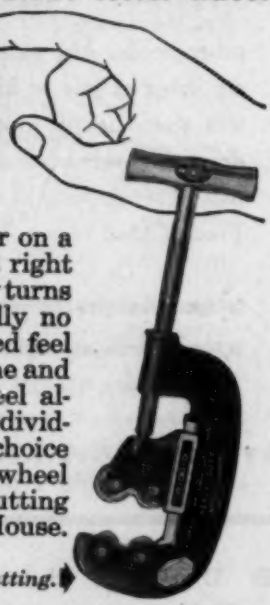
CORPORATION

Cut your pipe cleanly with more ease and speed with this new efficiency-balanced

RIGID

PIPE CUTTER

. . . with fast-action thin-blade cutter wheel



● Slap this new RIGID Cutter on a pipe, turn it tight and roll it right through your pipe in a few easy turns — thin wheel leaves practically no burr. You like the well-balanced feel of its new style malleable frame and the thin blade tool-steel wheel always cuts true—every cutter individually tested to assure it. Your choice of 5 sizes to 6" capacity and 4-wheel cutters to 4." For easier pipe cutting order RIGIDs, at your Supply House.

4-wheel No. 42 for fast quarter-turn cutting.

RIGID

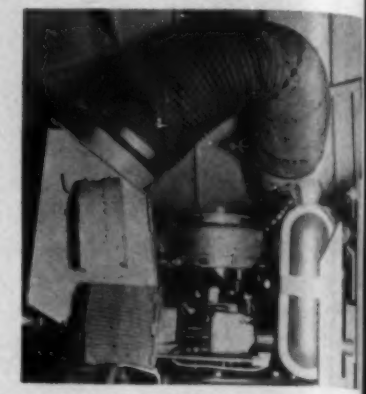
WORK-SAVER PIPE TOOLS

THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U. S. A.

by one man, is designed for cleaning pipe lines from 1 to 4 in. in diameter. The spun steel drum accommodates 100 ft of ½ in. flexible cable.

Flexible Ducting

No. 3068—"Multi-Flex" ducting, made of fabric, rubber, and plastics, is offered by the United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.



Developed to carry oxygen to the nostrils of horses which might be caught in enemy gas attacks and later adapted for use in heating, ventilating, and defrosting warplanes, the ducting is now offered for conveying air, dust, fumes, and abrasive substances on mechanical equipment and in industrial plants. Made of glass and asbestos fabrics impregnated with synthetic rubber and plastics, the material is said to withstand temperatures from -7 to 350 F. Wire reinforcements are not used as flexibility is obtained by means of corrugations.

Acquires Flow Meter Line

No. 3069—Penn Industrial Instrument Corp., 311 N. 17th St., Philadelphia, Pa., has purchased the flow meter division of the Cochrane Corp., Philadelphia.**

As previously announced, the present line of Cochrane flow meters will be manufactured exclusively for the Hays Corp., Michigan City, Ind. However, it is expected that a line of air operated controllers for temperature, pressure, flow, and level will be marketed directly by Penn through the present Cochrane flow meter representatives.

Bellows Type Low Pressure Gage

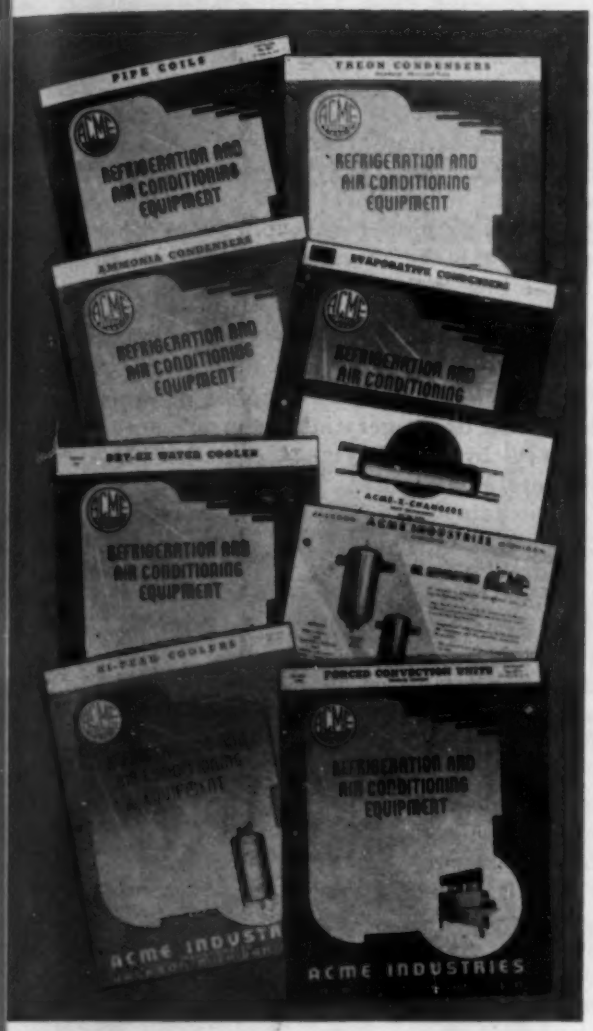
No. 3070—The development of a new bellows type low pressure gage has been announced by the Ashcroft Gauge Div., Manning, Maxwell & Moore, Bridgeport 2, Conn.

This gage is suitable for indicating draft pressures or any low pressures of gases or liquids that are not corrosive to bronze. The manufacturer states that it is especially recommended for use in gas plants. The pressure element is a self draining bronze bellows with a phosphor bronze calibration spring. Adjustable stops protect the bellows from excess pressure or vacuum. It is supplied in 4½ in. and 6 in. phenol cases with ¼ in. male pipe thread lower or back connection. The type 1188P is supplied in pressure ranges from 10 in. of water up to 10 lb pressure. It is also supplied as a low range vacuum gage, Type 1188 V, in vacuum ranges from 10 in. of water up to 20 in. of mercury vacuum.

Welding Electrode

No. 3071—A new all-position mild steel electrode, "Airco No. 312," has been announced by Air Reduction Sales Co., 60 E. 42nd St., New York 17, N. Y.

Did You Know
The Acme line is so complete?



Complete New Set of Catalogs

. . . write for the ones you need

You may already have an Acme catalog or two—but do you have all the Acme catalogs completely describing the various pieces of refrigeration and air conditioning equipment in the entire Acme line? Write for complete information on any equipment you may not already know about.

ACME INDUSTRIES

Refrigeration and Air Conditioning Equipment

Jackson • Michigan

Your pipe threading takes less time and effort with THIS direct-action No. 1R

RIDGID

Threads 1" to 2" pipe
Full-floating posts

Bushingless, quick-setting workholder

• If you prefer a poster threader, here's an improved one that's ready to thread 1", 1¼", 1½" or 2" pipe most quickly and with least bother. Quick-set foolproof workholder has no bushings to bother with. No cockwobble in threading—handle pulls head and dies directly, floating posts merely taper thread, do no driving. Alloy or high-speed steel chaser dies cut clean perfect threads, steel and malleable construction assures long service—and it sells at a popular price! . . Buy No. 1R at your Supply House.

RIDGID

WORK-SAVER PIPE TOOLS

THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U. S. A.

The Low Cost
Tal Portable Bender

Roller Lines

YOU'LL find it difficult to name another piece of equipment that has the profit possibilities for you that a Tal machine provides . . . for this light-weight, portable bender can be kept going for you day after day on all kinds of piping installations and repair work. With it you can bend cold, without filling, any steel or wrought iron pipe ⅜" to 3" to any desired radius in one uninterrupted operation. Even first day apprentices can do this instantly on the job—making perfect, smooth bends, free from kinks or wrinkles. You eliminate the use of manufactured bends, greatly reduce the need for fittings, and cut expensive welding up to 60% or more. The man-power this efficient machine saves, the hours of time it gains, the every day use it receives, repays its low cost in a short time. No wonder then that Tal benders are specified by the Army, Navy and Maritime Commission for what they do and how they do it . . . no wonder too, that thousands are already in use by large and small contractors from coast to coast—sold by leading jobbers everywhere. Ask your jobber or write, now, for a factual bulletin.

Outside Food Lines

HYDRAULIC PORTABLE TAL PRESTAL

Laboratory tests and field applications are said to indicate this electrode is satisfactory for welding (1) low alloy, high tensile steels, particularly in heavy sections where preheat must be used with conventional type electrodes to minimize cracking; (2) free machining steels which normally run quite high in sulphur; (3) cold rolled steels where excessive porosity is normally encountered with conventional type mild steel electrodes; and (4) material to be vitreous enameled after welding (this electrode is said to make possible production of satisfactory enameled surfaces without any preheat treatment prior to the enameling operation). It is also considered to be more suitable than conventional mild type steel electrodes on low alloy or mild steel applications where stress relieving would be desirable but cannot be accomplished, either due to lack of facilities or the magnitude of the application.

Quick Coupling

No. 3072—A new quick coupling designed for use on hoses and lines operating under pressure has been announced by the Roylyn Mechanical Laboratory, 8928 Santa Monica Blvd., Los Angeles 45, Calif.**

The coupling is said to be adapted for hydraulic and pneumatic lines running from pressurized tanks such as truck and trailer connections, fuel lines, paint sprayers, and air driven tools. It employs but three major parts —the cam ring, ball cage, and nipple. By rotating the cam collar steel balls are forced inward into a groove in the nipple, forcing the halves together. The gasket retained in the ball cage provides a seal against dirt as well as being the separating spring force necessary to the operation of the lock. A slight shoulder on the cam assures a positive lock; application of more pressure tightens it and only the cam collar can unlock it.

Tests made on the alloy steel model, says the manufacturer, showed a temperature operating range from –65 F to 300 F with safe pressure limits of 1680 psi for the 2 in. coupling and 11,500 psi for the ¼ in. unit. Couplings are available in aluminum, brass, alloy or stainless steel and pipe threads or flared tube connections are optional with caps to fit all sizes of nipples. Standard thread sizes run from ¼ to 2 in. Larger sizes available on special order.

Self Lubricating Valves and Slides

No. 3073—"Morganite" self-lubricating meter valves and slides for practically every type of liquid or gas are offered by the Morganite Brush Co., 3304 48th Ave., Long Island City 1, N. Y.**

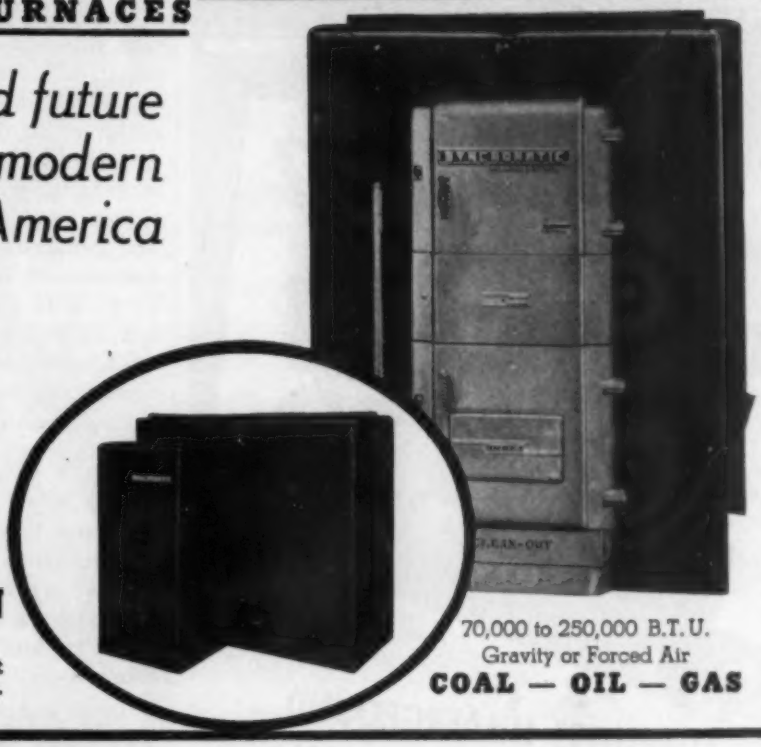
SYNCROMATIC

MODERN STEEL FURNACES

Invest in a sound future with the most modern Furnace line in America today.

See your jobber for details on

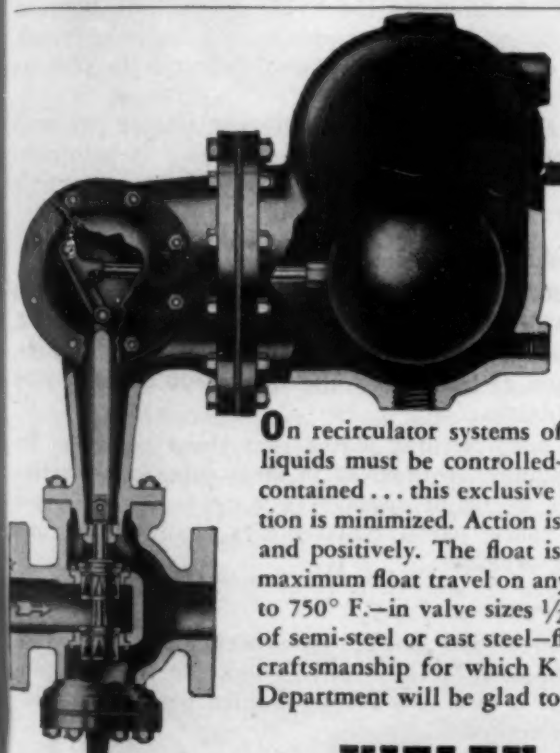
COAL
OIL
GAS
Steel Furnaces



70,000 to 250,000 B.T.U.
Gravity or Forced Air
COAL — OIL — GAS

SYNCROMATIC CORPORATION

Factories: Milwaukee and Watertown, Wis.
Offices: 5110 N. 35th Street Milwaukee, Wis.



NO "GLAND TROUBLE"

because UNITROL Level Controller has no packing glands or stuffing box

On recirculator systems of condenser hotwells, deaerators—or wherever the level of liquids must be controlled—UNITROL will do it more accurately! Simple . . . self-contained . . . this exclusive design eliminates trouble-making restrictive elements. Friction is minimized. Action is free and unhampered. Feed or drain is regulated promptly and positively. The float is linked to the inner valve through ratio connection, with maximum float travel on any size valve of only 7 inches. Available for temperatures up to 750° F.—in valve sizes ½" to 4"—integral casting construction—valve and floatcage of semi-steel or cast steel—float of seamless copper or stainless steel—and with the fine craftsmanship for which K & M has been recognized for 75 years. Our Engineering Department will be glad to make specific recommendations.

Write for Catalog 66-C

KIELEY & MUELLER, INC.
MANUFACTURERS OF PRESSURE AND LEVEL CONTROLS
2015 43rd St., North Bergen, N. J.

Awarded our employees for outstanding production achievement

ADSCO

Bannon

Tile Conduit

SIMPLIFIES UNDERGROUND TRANSMISSION OF STEAM, GASES AND FLUIDS

Standardized design of ADSCO-BANNON Tile Conduit simplifies layout, estimating and installation of underground lines. Look into its start-to-finish advantages for your spring and summer jobs. Write for quotation giving length of line, sizes of pipes, steam pressure and temperature. Complete installation data is supplied with each order.

Illustrated Bulletin 35-67 HP on request.

AMERICAN DISTRICT STEAM CO.

MAKERS OF UP-TO DATE STEAM LINE EQUIPMENT FOR OVER 65 YEARS

N. TONAWANDA, N. Y.

Shown here is a gasoline metering valve which, over a period of 18 months, is said to have effected a reduction of almost 90 per cent in operating impairments caused by friction, gumming, sticking, etc. According to the manufacturer, these valves and slides are immune to acids, alkalis, and most solvents, will function at temperatures up to 850 F, will not warp or stick in gum or hardening cold, and have a very low coefficient of expansion. In addition, depending upon speed and environment, any metal or alloy is considered as a satisfactory seat or mating face for this material.

Unite To Air Condition Busses

No. 3074—The Carrier Corp., 302 S. Geddes St., Syracuse 1, N. Y., has entered into an agreement with Tropic-Aire, Inc. (a subsidiary of The Greyhound Corp.), whereby the latter will handle Carrier air conditioning equipment exclusively in its domestic sales to bus manufacturing, owning and operating companies.

Total annual volume of business under the new arrangement was not predicted, but the announcement pointed out that "in the lively competition between bus, air and railway companies for postwar travel, major emphasis will be placed on comforts such as air conditioning."

The agreement, signed after comparative performance tests in which research engineers of both companies participated, unites two of the country's pioneers in bus air conditioning.

Welded Steel Valves

No. 3075—The new steel "Weldvalve" manufactured by the Hancock Valve Div., Manning, Maxwell & Moore, Inc., Bridgeport, Conn., is available in angle, gate, and globe designs and in the 600 through 2500 lb standards.

The manufacturer states that these represent an outstanding advancement in steel valve construction because of major savings in weight (30 to 60 per cent), space, parts, replacements, maintenance, and lagging expense.

New Gages

No. 3076—The United States Gauge Div., American Machine and Metals, Inc., Sellersville, Pa., has announced a new line of streamlined gages in a modernized design.

The streamlines of the neutral gray case are heightened by an ivory-toned dial with contrasting red and black graduations. The manufacturer claims longer life under adverse conditions for the new group of gages, which are also said to incorporate superior construction and readability while retaining the company's standards of precision.

WILLIAMS

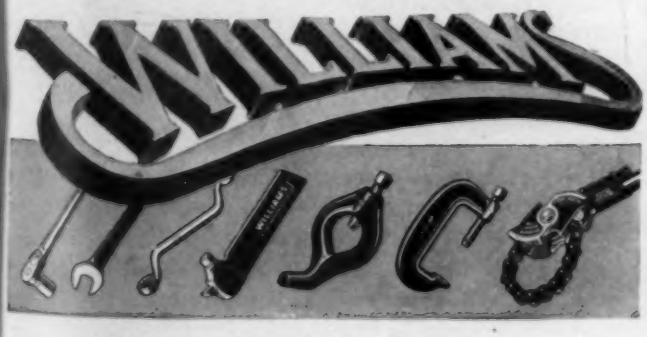
SUPERIOR DROP-FORGED TOOLS

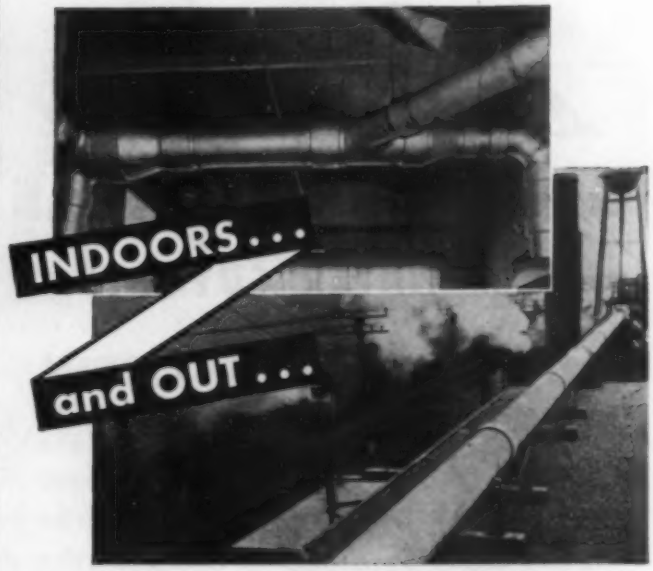
"VULCAN SUPERIOR" CHAIN PIPE TONGS

7 sizes, with either Flat Link or Cable Chain, for pipe and fittings 1/8 to 12".

● Pipe or fittings—it makes no difference to "Vulcan Superior," the universal service tong. You can switch from one to another without adjustment or change of parts. And "Vulcan Superior" is the only chain tong with *reversible* pipe-and-fittings jaws. When one set of teeth begins to wear, simply remove the Through-Bolt and reverse the jaws. Sold by Plumbing Supply and Industrial Distributors everywhere. Literature on request.

J. H. WILLIAMS & CO., BUFFALO 7, N. Y.





Here is a duct that Fights Corrosion!

MANY USERS of ducts, vents and stacks have found, in Johns-Manville Transite "S" Pipe, a practical answer to the problem of corrosion.

Strong and durable, this asbestos-cement pipe successfully resists many of the corrosive fumes, vapors, dusts and gases encountered in industrial operations.

Transite "S" Pipe is also immune to rust, as well as highly water-resistant. It needs no painting, whether used indoors or out. It is easily installed, light in weight, and comes in a range of sizes up to 36" in diameter. A full line of Transite fittings assures corrosion-resistance throughout the system.

Data Sheet DS-336 gives full details and is free on request. Address Johns-Manville, 22 East 40th St., New York 16, N. Y.

JM

Typical Industries in which Transite "S" Pipe is used—

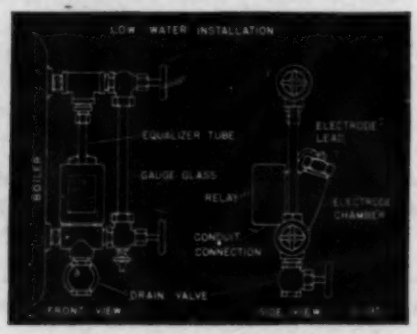
Aircraft	Foundry	Pulp & Paper
Automobile	Furnace	Quarrying
Baking	Furniture	Railroad
Bleaching	Gas	Rayon
Boiler Works	Glass	Refrigeration
Brewing	Laboratory	Rubber
Canning	Laundry	Shipbuilding
Ceramic	Leather	Shoe
Chemical	Match	Smelting
Dairy	Meat Packing	Soap
Drug	Metal	Soft Drink
Electrical	Mining	Sugar Refining
Explosive	Paint	Textile
Farm Machinery	Petroleum	Tool
Food	Potash	Water & Sewage

Johns-Manville TRANSITE 'S' PIPE

Positive
Low Water Control
GENERAL CONTROLS
LOW WATER CUTOUTS

These electric low water cut-offs are free of moving parts, glands or seals under pressure, thereby eliminating greatest drawbacks of usual cut-offs. Designed to work satisfactorily on any type of water from spring water to brines. Large electrode area. Low current density insures freedom of spot currents. Low installation cost. Low and line voltage types available. Line voltage types with double voltage coils, permitting either 115 or 230 volts A. C. connections at installation.

L-2 Series



General Controls' engineers will help you fill your specific needs. For complete specifications on automatic temperature, pressure and flow controls, request Catalog 52B. Nearby is a factory branch or distributor equipped to meet your requirements.

GENERAL CONTROLS
801 ALLEN AVENUE GLENDALE 1, CALIF.

FACTORY BRANCHES: PHILADELPHIA • ATLANTA • BOSTON • CHICAGO
KANSAS CITY • NEW YORK • DALLAS • DENVER • DETROIT • CLEVELAND
HOUSTON • SAN FRANCISCO • SEATTLE • PITTSBURGH
DISTRIBUTORS IN PRINCIPAL CITIES

Arc Welding Electrodes

No. 3077—Metal & Thermit Corp., 120 Broadway, New York City, has announced the addition of two new groups of high tensile arc welding electrodes to the "Murex" line.

These new electrodes, it is claimed, are the first to provide two complete series of all-position high tensile electrodes, one having an AWS-ASTM XX10 type of coating and the other a coating of the AWS-ASTM XX13 variety.

Developed to meet the requirements of fabricators of power plant piping and equipment, but applicable to a variety of welding applications involving high tensile steels, these new electrodes provide a wide range of mechanical properties and make it possible to select weld metal very closely matching many high strength steels in tensile strength and ductility.

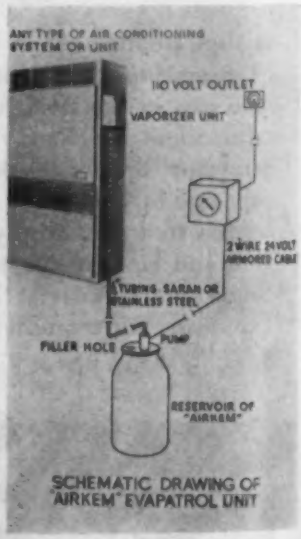
New Blower Wheel

No. 3078—The Lau Blower Co., 2001 Home Ave., Dayton 7, Ohio, has announced a new blower wheel which will soon be in quantity production.

This new series "A" blower wheel, made especially for the series "A" blower, will also be supplied separately. It is a center suspension wheel, which the company claims, has been tested in every way and has greater mechanical strength, truer concentricity and balance, and more efficient performance than the ordinary type of wheel. It is also claimed that this is the only wheel ever to be manufactured in motion. The end rings are assembled and locked to the blades in a spinning operation.

Air Freshening

No. 3079—The "Airkem Evapatrol System" for controlling odors and providing air freshening is offered by W. H. Wheeler, Inc., 7 E. 47th St., New York 17, N. Y., as a supplementary unit for air conditioning and ventilation systems.



SCHEMATIC DRAWING OF "AIRKEM" EVAPATROL UNIT

The unit consists primarily of a pump, a regulator, and a vaporizer. The liquid freshener, composed of a complex group of aromatic substances from plants and activated chlorophyll, is pumped from a reservoir to the vaporizer, which is cut into a side of the plenum chamber, where it is sprayed over a cartridge holding excelsior. Some of the air from the conditioner or from the ventilating system is passed through the cartridge and evaporation of the liquid takes place. According to the manufacturer, the regulator can be set to control the pumping and thus govern the rate of evaporation.

For non-conditioned spaces a portable unit, which contains a motor driven fan, is offered.

50,000
to
10,000,000 B.t.u.
with
WECO-N.G.E. Series F600

GAS BURNERS. For use in heating boilers, power boilers—in any metal firebox or sectional boiler.

Adaptable to any firebox shape or size.

Handles various gas pressures and effects low draft loss.

The Series F600 Burner operates on straight natural gas and mixed gas to 800 B.t.u. Gives perfect horizontal distribution. Full automatic controls—that operate properly—can be easily applied. *Write for F600 Bulletin.*

THE WEBSTER ENGINEERING CO.

TULSA —DIVISION OF— **OKLAHOMA**

Surface Combustion . . . . . Toledo, Ohio

Save Monthly Operating Costs

WITH THE NEW AIRTHERM DIRECT FIRED WARM AIR HEATER

High efficiency and low operating cost are a major consideration in any heating application. Low internal resistance through the Airtherm Warm Air Heater requires a minimum of motor horsepower, per B.T.U. output, resulting in savings in power costs to the user.

Investigate the highly efficient Airtherm for meeting your factory heating requirements. Write for bulletin 801 which will be sent on request.

AIRTHERM
MANUFACTURING COMPANY

711 S. Spring Ave., St. Louis 10, Mo.

This ½" Drill Cuts 3½" Holes!

The Black & Decker ½" Standard Drill is a great tool for fabrication and installation—on all types of heating, piping and air conditioning work. Has a capacity up to ½" diameter in steel, double in hardwood. Drives Black & Decker Hole Saws for cutting clean, round holes up to 3½" diameter in cast iron, sheet metal, porcelain, alloys or any material a hacksaw will cut.

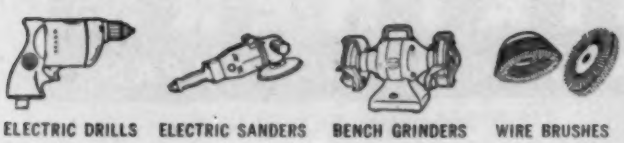
The same Drill drives wire wheel brushes and wheels for occasional light cleaning, grinding and sharpening jobs—and can be slipped into a Black & Decker Drill Stand ($22.00) for heavy duty drill press work.

Order now from your Black & Decker Distributor, or write to: The Black & Decker Mfg. Co., 628 Pennsylvania Ave., Towson 4, Md.

LEADING DISTRIBUTORS EVERYWHERE SELL

Black & Decker

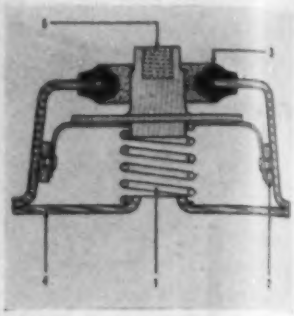
PORTABLE ELECTRIC TOOLS



ELECTRIC DRILLS ELECTRIC SANDERS BENCH GRINDERS WIRE BRUSHES

Anti-Vibration Mounting

No. 3080—A new anti-vibration mounting unit, for the protection of delicate equipment of all kinds, has been announced by Robinson Aviation, Inc., Teterboro, N. J.



Three standard sizes and a wide range of load capacities are offered for many applications such as fans, motors, blowers, compressors, and pumps.

According to the manufacturer, performance tests have shown that this new "Vibrashock Unit" averages better than 90 per cent absorption of vertical and lateral vibrations over a wide range of frequencies. The cross sectional view shown here illustrates (1) load-bearing stainless steel spring, (2) built-in damping mechanism designed to kill low frequency oscillation and to reduce resonance at critical frequencies, (3) three-way limiting snubbers designed to provide a resilient stop to limit heavy load shocks, (4) metal housing, and (5) load carrying central stud tapped for standard machine screws.

Insulation Firm Expands Manufacturing Facilities

No. 3081—Acceptance of its bid by the Reconstruction Finance Corp. has enabled the Owens-Corning Fiberglas Corp., 1842 Nicholas Bldg., Toledo 1, Ohio, to acquire a 35 acre industrial property in Kansas City. The purchase is described by the company as a major step in its expansion program.

Harold Boeschenstein, president of the corporation, said that facilities will be installed to manufacture "Fiberglas" building insulation and roofing material, pipe wrap for protection against underground corrosion, industrial insulation and equipment insulation. Part of the facilities of the plant will be used to manufacture fine glass fibers of a type newly developed for a wide variety of purposes.

Construction of buildings on the property is only one-fifth done and engineers will start immediately to revise the layout and adapt the design of remaining construction to the requirements of the manufacturing operations planned.

Canadian Company Organized

No. 3082—A new Canadian company, Penn Controls, Ltd., 284 King St., W., Toronto 2B, has been formed to manufacture and sell automatic controls for heating, refrigeration, pump and air compressor applications as well as safety controls for engines, according to Albert Penn, president of Penn Electric Switch Co. of Goshen, Ind.**

"This is but another step in the company's expansion program which started approximately two years ago. Anticipated market activity plus a desire to give better service to the company's Canadian customers prompted the organization of this company," stated Mr. Penn.

Arthur H. Hills, Canadian engineer and sales executive, has been appointed to manage this phase of the company's operations in Canada.

For STOKERS

The CROWN Unbreakable Coal Feed Screw

NOW AVAILABLE for Prompt Delivery

WELDED All-Steel Worm—All Sizes—All Pitches

★ Crown's complete line of all-steel Coal Feed Screws meets every replacement and production requirement. Produced for both domestic and industrial stokers. Crown Screws are available with right or left hand screws, in all sizes and pitches, tapered or straight, and in combinations of pitches. Uniformly smooth surfaces insure that coal will flow freely and easily through the flights. Because it is all-steel with continuous weld, the Crown Coal Feed Screw guarantees long, continuous operation with full customer satisfaction. Crown is in a position to make prompt delivery on all sizes.

In ordering give complete specifications on size and design.

CROWN IRON WORKS COMPANY

1202 Tyler St., N. E. *Since 1878* Minneapolis, Minn.

3-WAY GUARANTEE OF DEPENDABLE PERFORMANCE

Hydrovac

Super Vacuum Return Units

Not one, not two, but three guarantees highlight the quality and performance of Hydrovac units.

1. 3-year wear-proof guarantee.
2. Guarantee of a minimum of 25 inches of vacuum at 70° F. against a sealed inlet.
3. Guarantee that vacuum will not recede to zero, with unit at rest, in any time under 5 hours.

Note these features of Hydrovac's exceptional design and construction:

(1) Permoy Cast Iron Receiver; (2) Bronze Internal Parts; (3) Extra Large Shielded Bearings; (4) No Vacuum at Stuffing Box; (5) All facings machined; (6) Stainless Steel Rods; (7) Dash Pot Mechanical Valves; (8) Stainless Steel Bushings; (9) Wide Clearance Between Working Parts.

Get All the Facts Back of Hydrovac's Triple Guarantee. Write for the 4-page Bulletin 100-B.

AMES HYDROVAC INC.

200 SCHOLES STREET BROOKLYN 6, N. Y.

In Los Angeles, it's
Warren & Bailey Co.,
350 S. Anderson St.

PROMPT DELIVERY of Novoid Cork Pipe Covering can now be obtained through good insulation contractors throughout the U.S. Many Novoid contractors maintain warehouse stocks for immediate installation.

Novoid Covering is the moulded rigid insulation that efficiently reduces your cost of refrigeration. It snugly hugs pipes and fittings of every size and shape, does not sag, does not absorb moisture or odors, and is long-lasting.

For complete facts about Novoid Pipe Covering, Corkboard, and sundries specially developed to make low-temperature insulations most efficient, write to Cork Import Corporation, 330 West 42nd Street, New York City.

NOVOID INSULATION

CORKBOARD • PIPE COVERING

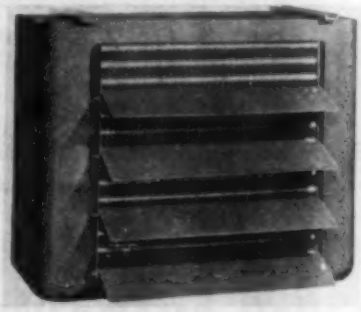
Direction Finder For Sun Rays

No. 3083—The "Graphic Solarmeter," patented and marketed by R. W. Justice, Belvedere, Marin County, Calif., is designed to indicate the direction of the sun's rays at any hour throughout the year.

An especially calibrated instrument is offered for each of nine bands of latitude, the nine types covering the United States; and the accuracy is said to be approximately within 3 per cent. According to the designer, it is useful for determining whether or not solar radiation will affect certain walls and windows at various hours throughout the year and may be used at the building site or with a drawing.

Blower Units for Low Temperature Cooling

No. 3084—Now in production at the Rempe Co., 362 N. Sacramento Blvd., Chicago 12, Ill., is a new line of blower units for low temperature cooling.

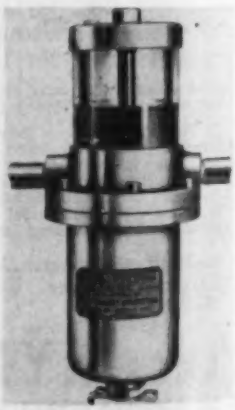


The unit consists of a cooling coil, propeller type fan and motor, adjustable louvers, and a bonderized steel housing. Coils for sulphur dioxide, methyl chloride, "Freon", and anti-freeze are made of tinned copper tubing with aluminum fins. Coils for ammonia and brine are of seamless steel tubing with steel fins, all hot galvanized after fabrication. Tubes are ⅝ in. O D with a wall thickness of 0.035 in. and fins are 0.015 in. thick.

Since coils are available for a variety of refrigerants, including brine and anti-freeze solutions, the units are said to be suitable for maintaining refrigerator temperatures from 11 to 45 F.

Filter and Lubricator for Pneumatic Equipment

No. 3085—The "Filter-Lube," a pneumatic filtering unit combined with a lubricator, is announced by CCA Products Engineering, P. O. Box 671, Glendale, Calif.**

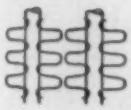


Primary use of the unit is to prolong the life of all types of pneumatic equipment, prevent freezing of air-operated devices, and deter the inroads of corrosion.

It is available in ¼, ⅜ and ½ in. standard pipe sizes and incorporates a transparent plastic lubricator oil reservoir, a needle valve oil regulator, and a lower element which forms a sludge basin and contains a wool felt filter media.

Deep flanges extruded into headers give abundant tube brazing area.

Stream-lined copper tubes combine aerodynamic and heat transfer efficiency.



Individual copper fins have large-area bond to tubes Individual tubes "give" laterally to relieve expansion stresses between adjacent tubes.

Full floating element mountings relieve expansion stresses between core and cabinet.

Electrically welded cabinet provides rugged strength.

Low final temperatures for maximum comfort distribution.

Modern broad blade fans for quiet operation.

Rubber mounted motors contribute to vibrationless performance.

Made in a complete line from 100 to 1,000 EDR.

FEDDERS-QUIGAN CORPORATION

BUFFALO 7, N. Y.

RETURNED VETERANS AND FAMILIES WANT ECONOMICAL SMALL HOME HEATING . . . WITH *Automatic Temperature Controls . . .*

Serve This Great and Profitable New Market By Selling Vaporizing Oil Burner Appliances Equipped with Dependable "A-P" Constant Level Oil Controls . . . . .

PERFORM a genuine service for the great army of returning service men eager to establish and enjoy modest, comfortable homes for their families. Tell them about the convenience, economy, and all-around efficiency of heating with vaporizing oil burner space heaters, floor furnaces, and basement furnaces equipped with a dependable "A-P" Constant Level Oil Control that assures uniform home heating automatically. You will be building customer good-will as well as profitable sales volume!

Leading makes of Vaporizing Oil Burner Appliances equip their units with the dependable, fuel-saving "A-P" Constant Level Oil Control. It is to your immediate and profitable advantage to feature this efficient equipment that affords smaller type homes such genuine heating comfort and economy.

WRITE for new illustrated Bulletin describing the "A-P" Constant Level Oil Control with "Magic Pilot."

Illustrated is the "A-P" Model 240 WYP Constant Level Oil Control for water heaters—equipped with "Magic Pilot." The "Magic Pilot" also is available on other model controls for vaporizing burner floor furnaces and furnaces, where a low pilot flame must be maintained indefinitely.

AUTOMATIC PRODUCTS COMPANY

2460 North 32nd Street, Milwaukee 10, Wisconsin

DEPENDABLE *Oil Controls*

A-P CONTROLS ARE DESIGNED TO ELIMINATE SERVICING!

INSULATE EVERY DUCT

with Asbestos Protected

DUX-SULATION

. . . FOR A BALANCED AND CONTROLLED OPERATION OF AIR CONDITIONING SYSTEMS

Saves 75% of Bare Duct Heat Loss

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Thermal Insulating Efficiency of 70%

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K Factor .27 B. T. U.

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Frictional Resistance F = 0.0001322

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Deadens Metallic Noises

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Absorbs 70% of Air-borne Noises

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Prevents Condensation

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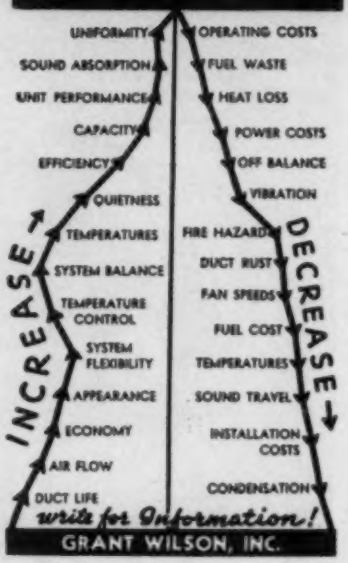
Complete for Easy Installation



DUX-SULATION is the Asbestos Protected Insulation Felt that excels in every operation from cutting to finishing and insulates against heat, cold and sound. It is a proven product designed and developed especially to be the most satisfactory and efficient insulation for Ducts.

DUX-SULATION is approximately ½" thick and is composed of millions of fine flexible fibres fabricated into a Felt of unusual strength. The fineness of fibres and manner in which they are built gives you the many dead air spaces so necessary for high thermal insulation and sound absorption.

A heavy Asbestos membrane is woven into the Felt body just below the soft surface which gives you the protection of fire-proof Asbestos. The outer or top surface is a heavy woven fabric through which the fine fibres are worked so that the top surface is finished into an attractive sound absorber.

DUX-SULATION can be applied to round pipes, rectangular ducts or irregular surfaces. It bends in any direction, even to very sharp and abrupt angles. It sweeps over the duck work as though it were a part of the sheet metal itself. When the tape is neatly applied to the corners and the joints, you have a very attractive completed job that harmonizes with almost any surrounding.

GRANT WILSON, INC.

141 WEST JACKSON BLVD. AT LA SALLE ST. . . CHICAGO 4, ILL.
(22nd Floor Board of Trade Bldg. Phone Wabash 8220)

Send bulletin No. 407-H containing the full story of DUX-SULATION—the all purpose insulation.

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STREET.....

CITY.....STATE.....

ATTENTION OF.....

• RECENT TRADE LITERATURE •

For your convenience in obtaining copies of these bulletins, see coupon on page 187. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending in your request to Heating, Piping & Air Conditioning.

Bolting for Pipe Flanges And Pressure Vessels

No. 6080—A two part article, Bolting for Pipe Flanges and Pressure Vessels, by Sabin Crocker, senior engineer, mechanical system engineering dept., Detroit Edison Co., is contained in vol. 2 no. 4 and vol. 3 no. 1 of Fasteners, published by the American Institute of Bolt, Nut, and Rivet Manufacturers, 1550 Hanna Bldg., Cleveland 15, Ohio.

The author has briefly reviewed recommended practice as set forth in the various American standards and the ASTM specifications for bolting. The discussion, which primarily covers material specifications and dimensional standards, should be of interest to those concerned with this subject.

Cooling Tower

No. 6081—An 8 page bulletin issued by the Cooling Tower Div., Rogers Diesel and Aircraft Corp., 1120 Leggett Ave., New York 59, N. Y., illustrates and describes "Coey Floating Film" cooling towers. In the design of this unit emphasis is on surface cooling the many small droplets of water. Counterflow air at 1500 fpm velocity is used to break up the cooling water and aid in forming the droplets.

Corrosion of Steels

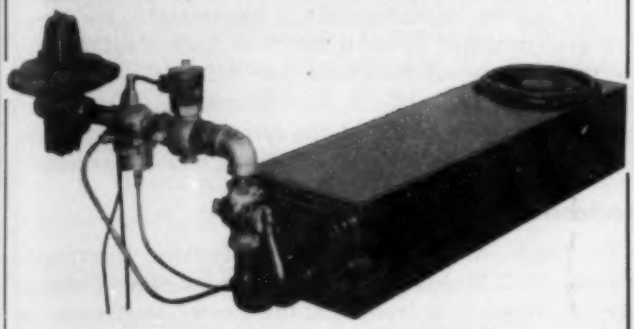
No. 6082—Corrosion of Steels, a 16-page 6x9 in. booklet published by Carnegie-Illinois Steel Corp., Carnegie Bldg., Pittsburgh, Pa., and other subsidiaries of United States Steel Corp., indicates how various commercial steels may reasonably be expected to resist the attack of atmospheric corrosion in particular. The summary, brought up to date by Dr. John Johnston, director, Research Laboratory, U. S. Steel Corp., includes only information now generally accepted as reliable. Copies may be secured upon request to any Carnegie-Illinois Steel Corp. office.

According to this booklet, "prevention of undue corrosion of steels in service is not a single problem but comprises a multitude of problems, each of which must be investigated separately. The ordinary accelerated test is far from a trustworthy indicator of what will happen to the metal in any environment other than precisely that in the test itself and great caution must be exercised in interpreting the results." Accordingly, the information and data given are based largely on the results of field exposure tests.

Cutting Cast Iron with Oxy-Acetylene Flame

No. 6083—The National Cylinder Gas Co., 205 W. Wacker Dr., Chicago 6, Ill., has issued an illustrated circular (N-606) describing the cutting of cast iron

JOHN ZINK'S CONVERSION



BURNER
with
Automatic Controls

Series SC-300. Conversion gas burner, burns 175 cubic feet of gas per hour.

FEATURES

- Applicable to 98% of all domestic furnaces, for new installations or conversions.
- Furnished with standard electric controls—Thermostat, Transformer, Solenoid Valve, and Safety pilot.
- Converts Coal, Oil and Unsatisfactory Gas burners into GOOD HEAT PRODUCERS.
- Burns artificial and mixed gases as well as natural gas.
- LUMINOUS FLAME type.
- Provides automatic heat at lowest equipment cost of any appliance on the market.
- Easily installed — Quickly inspected.
- Complete piping, burner head and pilot assembly may be removed for inspection and cleaning in a few minutes.

Write for descriptive literature

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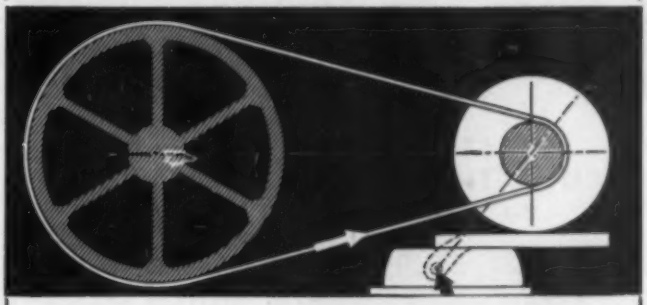
7 YEARS OF CONTINUOUS SERVICE WITHOUT STOPPING . . . Except for Christmas Day . . . reports a big TANNATE-ROCKWOOD user.



TANNATE ROCKWOOD DRIVES Can Help You Too!

TANNATE flat belt short center drives assure correct belt tension—regardless of load, centers or unusual conditions, the weight of the motor maintains proper tension at all times. This means longer service life for your equipment.

The TANNATE flat leather belt has a very high coefficient of friction and great pliability that helps keep machines running at top speed. It is treated to resist moisture, oil and weak acids. TANNATE has unusually high tensile strength which contributes toward increased service life and reduced maintenance expense.

Motor base, one or both pulleys and belt are supplied by Rhoads. Designed to work together, they give superior performance. Maximum speed is maintained, and driven machine capacity is often increased when TANNATE-ROCKWOOD flat belt units are put on your drives. Get the most efficient and economical drives for your machines. Ask us for further details.

RHOADS
Tannate-Rockwood
SHORT CENTER DRIVES

Established 1702

J. E. RHOADS & SONS

35 North Sixth Street, Philadelphia 6, Pa.

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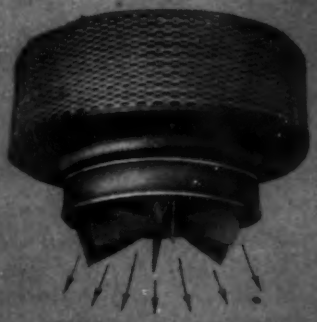
McCORD
HEATING AND
AIR CONDITIONING
PRODUCTS

BLAST HEATING COILS—AIR CONDITIONING COILS—ALL TYPES

All copper spiral fin tube construction with the tubes formed or bent permits uniform expansion without strain. Headers are heavy wall construction with tubes brazed into extended ferrules formed in the headers. Fins are helically wound and metallically bonded. May we send catalog?

VERTICAL TYPE UNIT HEATERS



A proven heating unit, modern in design, incorporating every unit heater advancement. McCord copper spiral fin tube construction creates air turbulence without undue restriction. Improved fan blades deliver large volume of air with minimum air noise. Guaranteed for 150 lbs. saturated steam pressure. Specify McCord.

HORIZONTAL TYPE UNIT HEATERS

A time proven heating unit, modern streamlined in design, quiet, yet its rugged construction adapts it to all types of installations, guaranteed for use on No. 150 p. s. i. steam pressure. All copper heating element, individual spiral fin tubes free to expand without strain on joints. Standard motors with standard bases used. Wide range of capacities.

Save fuel with McCord Unit Heaters.

McCord CORPORATION
DETROIT 11, MICH.

with the oxy-acetylene flame. Included is a discussion of the recommended types of equipment, preheating conditions, cutting positions, proper oxygen and acetylene pressures, and the need for adequate protective clothing.

Dust Collectors and Filters

No. 6084—A brief discussion of filter arrestance ratings and the fundamentals of electrostatic air filtration are contained in vol 6 No. 3 of Dust Engineering, the house organ of American Air Filter Co., Inc., 107 Central Ave., Louisville 8, Ky. Numerous examples of applications in industry of the company's line of filters and dust collectors are also described and illustrated.

Electrostatic Air Cleaning

No. 6085—A 50 page illustrated booklet, Electronics Digest (B-3726), designed to keep management groups abreast of modern trends in the use of electronics, is published quarterly by Westinghouse Electric Corp., Box 868, Pittsburgh 30, Pa. Explanations of the electron theory and of basic electronic devices are given and the subject of electrostatic air cleaning is among the various specific applications which are covered.

Fans and Unit Heaters

No. 6086—A pictorial trip through the plant of the Ilg Electric Ventilating Co., 2850 Crawford Ave., Chicago 41, Ill., is provided in a new 36 page booklet (Form No. 103). The fabrication and assembly of motors, centrifugal, vaneaxial, and propeller fans, and unit heaters are shown. Also illustrated is the use of the company's research laboratory.

Flow Meters

No. 6087—Flow rate indicating, recording, controlling, and totalizing meters are featured in bulletin No. 45-A, which has been published by Fischer & Porter Co., 7346 County Line Rd., Hatboro, Pa. "Rotameters" for various gases and fluids, ranges of pressure, and flow rates are described and a bead-guide tube which is said to eliminate the use of float guide rods and other float stabilizing means is also discussed.

Fuel Oil Heaters

No. 6088—The Whitlock Mfg. Co., 100 South St., Hartford 1, Conn., has released a new bulletin (No. 35) featuring the company's line of fuel oil heaters. Among the types described are straight tube heaters with fixed tube sheet construction, straight tube design incorporating a flexible expansion member, U tube heaters with removable bundle construction, a coil pipe heater, and heaters designed for special uses such as withdrawing heavy oil from large storage tanks.

Handbook of Stainless Steel

No. 6089—Allegheny Ludlum Steel Corp., Brackenridge, Pa., has issued a new 5x7½ in., 100 page handbook which contains data on 26 types of stainless steels. Also included are a 44 column finder table, corrosion resistance to 230 materials, discussions of properties, products, available forms and sizes, and fabrication methods. This handbook supersedes and amplifies the chapters of the earlier Handbook of Special Steels and

IN STOCK FOR IMMEDIATE SHIPMENT

EXHAUSTING TYPE BLOWERS

340—Type 250-ELS American Industrial Fans. Inlet 10½"; Outlet 9⅞" x 8-9/16".

1—Type 350-ELS-B-1 American Industrial Fan. Inlet 14⅝"; Outlet 13⅞" x 11-15/16".

VOLUME TYPE BLOWERS

2—Buffalo Axial Flow Blowers, Size 32; with built-in 15 HP Wagner Motor, 3-ph., 60-cy., 440-volts, 1750-rpm.

7—Size 4½, Type HS, American Fans. Inlet, double 28"; Outlet 27⅜" x 37⅜".

1—Size 5, Type HS, American Fan. Inlet, single 32"; Outlet 30-7/16" x 24¼".

1—Size 6½, Type HS, American Fan. Inlet, double 45⅞"; Outlet 55¾" x 40⅛".

62—Size 121-FM, Type ACF American Fans. Inlet 17"; Outlet 29" x 21½".

65—Type 350-Al American Utility Blowers. Inlet 22"; Outlet 16¾" x 21⅝".

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These Blowers are suitable for forced and induced shaft service, heating, ventilating and air conditioning.

All Industrial Type "E" Exhausters are equipped with clean-out doors and rotating radiation and cooling shields.

Units are completely reconditioned, cleaned, painted and guaranteed. Prices and operating data will be furnished upon request.

MORSE BROS. MACHINERY COMPANY

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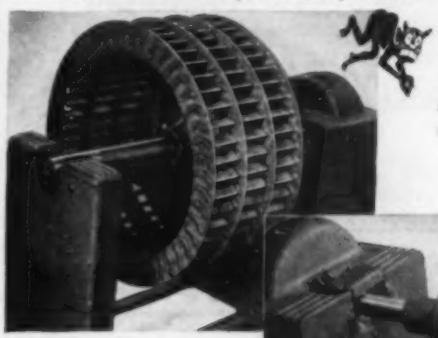
MACHINING *ALONE* CAN'T CORRECT DY-NAMIC UN-BALANCE

Save shop time, add years to product life, with a low-cost, quick-acting Bear Dy-Namic Balancer!

Get *FREE* Catalog!

Every day, production-sampling tests prove definitely that workmanship, however fine, simply cannot insure dy-namic balance in rotating parts. And since destructive unbalance increases enormously as RPM steps up . . . and since the resulting "wobblies" are discovered by the user and not in your shop . . . it stands to reason that scientifically accurate dy-namic balancing is essential if your products are to serve better and sell easier.

NOW DY-NAMIC BALANCING IS QUICK, EASY, LOW-in-COST!



Bear-balancing a blower.

Bear-balancing a machined casting.

No longer does dy-namic balancing cost too much in time, equipment and operator-education. Bear has ended that! Now, with a low-priced Bear Dy-Namic Balancer the job can be done as a part of routine production. In a matter of seconds, a job of balancing can be done that will meet any standard requirement. So easy to operate that any shop hand can learn to Bear Balance in a few hours!

GET INFORMATIVE *FREE* CATALOG

See how quickly and easily, and at what low cost, you can give your products the operating and sales advantage of Bear Dy-Namic balancing! The Bear line embraces models for balancing bodies from a few ounces to tons . . . yours is here! Write for the Bear catalog! BEAR MFG. CO., Industrial Div., Dept., HPAC, Rock Island, Illinois.

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BEAR
COMBINATION
STATIC AND DY-NAMIC BALANCING MACHINES

ATTACH TO LETTERHEAD—MAIL!

Bear Mfg. Co., Indus. Div., Dept. HPAC, Rock Island, Ill.

Gentlemen: At no cost or obligation to me, please send me your catalog.

My Name_____

Address_____

includes most of the data and information that are available on the file size "Blue Sheets" of reference data on stainless steels.

Heat and Corrosion Resisting Steel

No. 6090—"Armco" Aluminized Steel is the title of a 24 page booklet that describes sheet steel, aluminum coated on both sides, which is said to resist heat scaling up to 1500 F, to maintain a bright, shiny appearance after prolonged heating up to 900 F, to resist atmospheric corrosion, and to provide good radiant heat reflectivity. The booklet, which is profusely illustrated, is offered by the American Rolling Mill Co., 939 Armco Ave., Middletown, O.

Heating and Air Conditioning Equipment

No. 6091—A discussion of the relative advantages and most suitable applications for water spray, steam jet, and evaporating pan type humidifiers is featured in the February issue of the house organ, Weather Magic, published by the Trane Co., La Crosse, Wis. Installations of some of the company's line of heating and air conditioning equipment in a candy plant and in a street car barn are also described. Several examples of the use of an industrial float trap, which discharges air and condensate continuously, are included.

Heating and Air Conditioning Plant Expansion

No. 6092—A description of a half million dollar addition (now under construction) to its Racine plant is featured in the January issue of the house organ published by the Modine Mfg. Co., 1772 Racine St., Racine, Wis. A description of unit heater installations in a church and a direct suspension feature for unit heaters are also included.

Heating, Ventilating, And Air Conditioning

No. 6093—A brief description of a radio and phonograph manufacturing plant, a 364 unit housing project, Navy floating drydocks, a synthetic rubber manufacturing plant, and a theater is contained in Vol. 9 No. 7 of Weather Magic, the house organ of the Trane Co., La Crosse, Wis. Applications of this company's heating, ventilating, and air conditioning equipment are featured, and the second section of a two-part article on reverse cycle refrigeration is included.

Hole Punching in Sheet Metal

No. 6094—Type "BL" hole punching units, which are said to be independent, self-contained units having the punches, dies, stripping guides and springs, and guide buttons designed in a holder which aligns the punches and dies, are described and illustrated in a 39 page bulletin (catalog BL) issued by Wales-Strippit Corp., 345 Payne Ave., North Tonawanda, N. Y.

Hose

No. 6095—Hose for handling air, water, steam, acid, paints and solvents and for use in sand blasting and in fire protection are described in a 24 page folder offered

PREHEAT FOR PROPER HEAT

WHITLOCK
FUEL OIL HEATERS

The Whitlock Type V-1 Oil Heater shown above is of simple standard design at moderate cost. These units in all-welded construction, adapted to high working pressures are *immediately available from stock.*

Whitlock Fuel Oil Heaters of more elaborate design are made to suit individual operating conditions and engineered for any combinations of temperature rise, operating pressure and capacity. Incorporating Whitlock's experience of many years in the fabricating of such equipment, they guarantee a unit to suit your requirements for economy and efficiency.

Our engineers will gladly discuss your fuel oil heating problems and make specific recommendations. Write for new Bulletin No. 35 describing and illustrating the complete line of Whitlock Fuel Oil Heaters.

THE WHITLOCK MANUFACTURING COMPANY
44 South St., Elmwood, Hartford 1, Conn.

New York Boston Chicago Philadelphia Detroit Richmond

Authorized representatives in other principal cities.
In Canada: Darling Brothers, Ltd., Montreal

Established 1891 — Ahead of the Times for Half a Century

Unless you are pretty sharp-eyed, you'll pass by "old man walking stick" as just another dead twig on a tree.

And there are a lot of other things that look different from what they really are . . . for example, certain cut-rate plumbing supplies. The wise plumber will avoid the pitfalls that come with inferior merchandise by relying on the reputable jobber in his vicinity.

Dollar for dollar, the trade-marked, quality merchandise he stocks is your best plumbing buy.

KUHNS BROTHERS CO.
DAYTON 1, OHIO

K
CAST FITTINGS

"K" fittings are carried in stock at Malleable Iron Fittings Co., Branford, Conn.; M. I. F. stocks at Kuhns Bros. Co., Dayton, Ohio.

WHEN YOU EQUIP
YOUR RETURN LINES WITH
Schaub DRAINTROLS

• Draintrols provide quicker heat-up at starting time . . . there are no delays waiting for equipment to reach operating temperature . . . AIR and CONDENSATE are discharged instantly . . . Machines hold uniform working heat all day long . . . *Net results are more production and greater profits* . . . Draintrols have no moving parts to get out of order —they replace ordinary traps on existing "open" systems.

Write today for full information.

FRED H. SCHAUB ENGINEERING CO., INC.
326 W. Huron Street Chicago 10, Illinois

The SCHAUB Heat Reclaim System

Step up the steam capacity of your boiler with the same fuel, if you have a regular open system. Our patented hot water heat exchanger, with the Schaub Heat Reclaim System, transfers "flash" heat (ordinarily lost out of the vent) from the returns to the feed water on its way to the boiler. Resulting higher feed water temperature (240 degrees to 280 degrees) increases boiler capacity. This means little or no drop in steam pressure when feed water is admitted to the boiler.
Write for details.

The Key to Boiler Room Efficiency
SCHAUB SYSTEMS

PUT the sun at your finger tips with the new Graphic Solarmeter! If you are an engineer you can use the Solarmeter to modify heating and cooling load calculations to compensate for solar heat. If you're a salesman of heating or air conditioning equipment you can use it to demonstrate to prospects. If you are planning a building, use the Solarmeter to orient wings, walls, windows, overhangs, etc.

The Graphic Solarmeter is handy as a T-Square —and just as easy to use. Simply turn the dial to line up hours and days desired—and you see instantly the sun's position by hours throughout the year. You can know precisely when any part of a structure—proposed or existing—will get sunlight and what the direction and inclination of the rays will be. No matter where you are located in the U. S., there is a Solarmeter calibrated to your band of latitude.

For several months, Solarmeters will be available only through mail order. Supply of sheet plastics is still limited. To be sure of getting a Solarmeter, order yours today! (See coupon below).

Sales Managers attention! Your salesmen will sell more profitably with Solarmeters in their kits. Ask for sample and quantity prices.

Please send me a GRAPHIC SOLARMETER calibrated to my particular band of latitude: ☐ Enclosed is my check for $3.00. (Purchase price to be promptly refunded if I am not satisfied.) ☐ Send me a SOLARMETER for one week trial without obligation.

NAME: .....

ADDRESS: .....

R. W. JUSTICE, BOX 122-H, BELVEDERE, MARIN COUNTY, CALIF.

by the Amazon Hose & Rubber Co., 130 N. Jefferson St., Chicago 6, Ill. Hose couplings and fittings are also covered and price lists are included.

Hot Water Heating Control

No. 6096—For regulating the temperature of hot water supplied to radiators, convectors, and radiant panels a 3-way modulating type, mixing valve, which is controlled by a weather thermostat, is featured in a new 4 page pamphlet issued by Sarcotherm Controls, Inc., 280 Madison Ave., New York 16, N. Y. Also discussed is the company's "Thermoray," which may be substituted for the conventional type room thermostat in radiant heating installations.

Industrial Heat Insulation Materials

No. 6097—Some 40 odd heat insulation products of materials such as magnesia, asbestos, sponge, diatomaceous earth, calcined aggregate, mineral wool, corrugated asbestos, together with insulating, bonding, and refractory cements are covered in a new catalog, Heat Insulation for Industry, released by the Philip Carey Mfg. Co., Wayne Ave., Lockland, Cincinnati 15, O. Data for determining insulation thickness and comparative efficiencies and other pertinent information are included.

Industrial Thermometers

No. 6098—A new line of straight stem and angle form industrial type mercury thermometers is featured in an 8 page folder issued by the Moeller Instrument Co., 132nd St. and 89th Ave., Richmond Hill, N. Y.

AIR CONDITIONING ENGINEERS

Positions are open to Mechanical Engineers possessing a sound knowledge of Air Conditioning and Ventilation, and who are qualified to layout and design complete systems and prepare engineering drawings.

Interesting opportunities are offered on our regular engineering staffs in long established offices, located on the East Coast, Central West, Gulf Coast, and West Coast.

THE AUSTIN COMPANY

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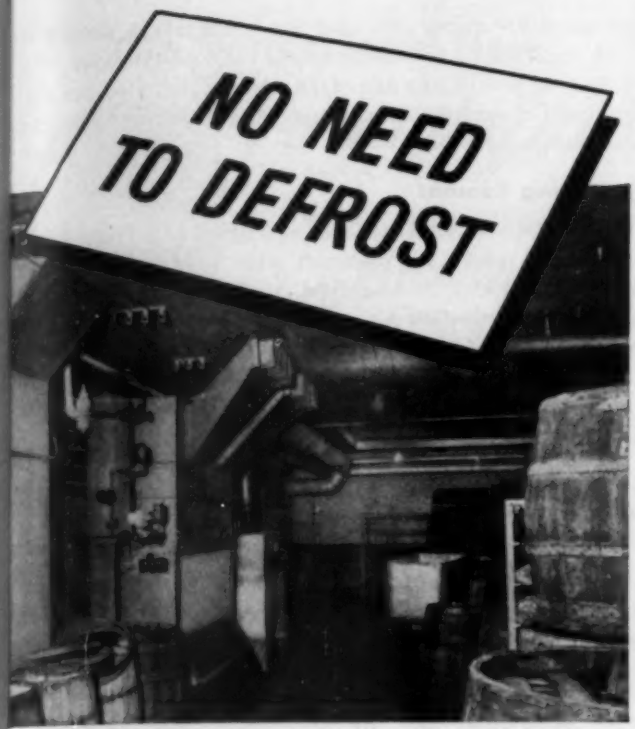

In freezing fruits or vegetables, or ice-cream, or in the cold storage of farm and dairy products, fish or meat—extra profits are realized by increasing production, improving quality, preventing spoilage and reducing operating costs.

The Niagara "No-Frost" Method prevents cooling coils from icing, which insures constant full capacity, thus increasing production.

It quickly brings products to the correct temperatures, thus improving quality.

"No-Frost" Spray Coolers have capacity to hold refrigeration and product temperatures constant, thus preventing spoilage.

The "No-Frost" Method uses less power, thus reducing operating costs.

The Niagara "No-Frost" Method gives month after month trouble-free operation, thus eliminating major maintenance expense.

Write for descriptive bulletin No. 83 today.

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Over 30 Years of Service in Industrial Air Engineering

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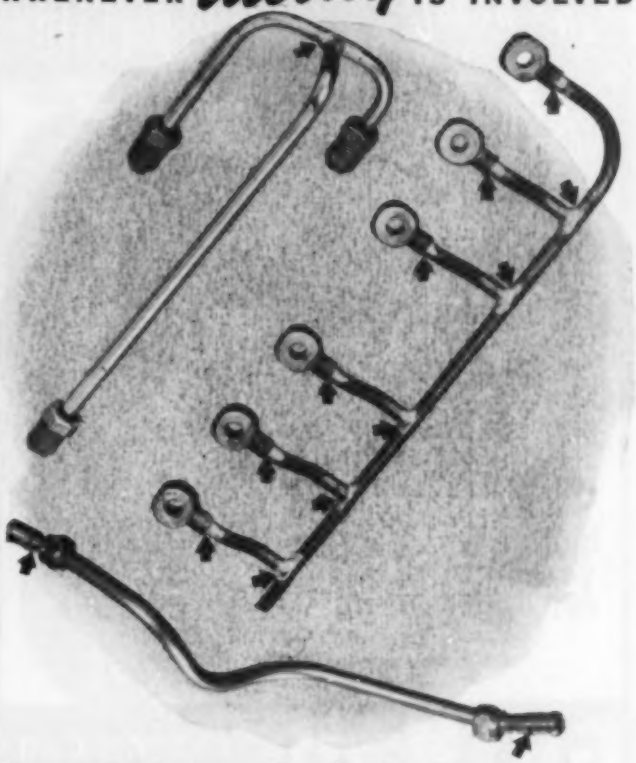

it pays to design for and specify SIL-FOS or EASY-FLO brazing

It pays because you get a better job at lower cost. For these two low-temperature silver brazing alloys readily and reliably make liquid and gas tight joints—joints with all the strength and ductility of the parent metals to withstand vibration, shock and temperature changes—joints that offer strong resistance to most corrosive agents—in short, **joints equivalent to the solid tubing in all essential properties.** And the Handy & Harman patented alloys, SIL-FOS and EASY-FLO make production of these strong, lasting joints a surprisingly low-cost operation—on either ferrous or non-ferrous tubing.

FOR COMPLETE FACTS—WRITE FOR BULLETIN 12-A

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Insulating Cement

No. 6099—Insulating cement, produced from black rock wool, which is combined with long-fiber asbestos and colloidal clay, is described in a 4 page folder issued by the Baldwin-Hill Co., 564 Klagg Ave., Trenton 2, N. J. This insulation, type "No. 1," is said to be effective up to 1800 F and reclaimable up to 1200 F. Thermal conductivity data together with recommendations for application are included.

Lining for Industrial and Process Equipment

No. 6100—Various lining materials such as bakelite, thiokol, vinyl, neoprene, and other synthetic rubbers and plastics which are designed for resistance to acids, alkalis, gasoline, oils, organic solvents, and abrasion are described in a 4 page folder issued by Industrial Lining Engineers, Inc., Sewickley Post Office, Edgeworth, Pa. Also mentioned are the consulting and contracting services of this company.

Lubrication in Refrigeration

No. 6101—The December 1945 issue of Lubrication, published by the Texas Co., 135 E. 42nd St., New York 17, N. Y., contains an article on Lubrication in Low

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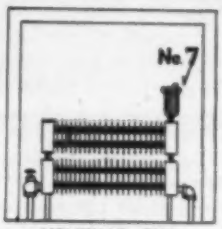

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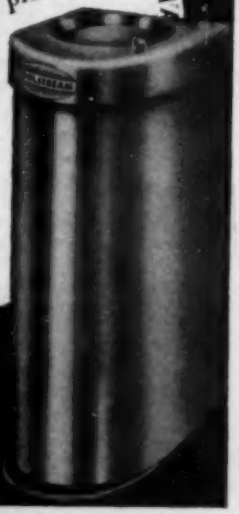

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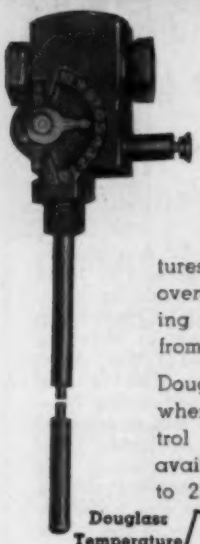

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Temperature Refrigeration. The more common types of compressor lubrication systems, pour point tests, and wax floc are discussed. The importance (in lubricating oils) of freedom from wax and water, solubility of water in the oil, and viscosity reduction due to miscibility of oil and refrigerant are also covered.

Mechanical Packings Manual

No. 6102—A new 336 page manual on the selection of mechanical packings types, their application and the design of adjacent parts in hydraulic or pneumatic equipment, has been published by Graton & Knight Co., 356 Franklin St., Worcester 4, Mass. Both leather and synthetic rubber packings are discussed and operating conditions governing the selection of materials are covered. Over 100 drawings, many photographs, and nearly 50 reference tables are included. The book is indexed to lead the design engineer from the selection of the proper type of packing to its installation in a correctly designed recess. Copies of this leather bound manual are available at $4.50 each and orders should be sent to the manufacturer.

Metal Working, Heat Treating, Machining and Rust Prevention

No. 6103—Reasons for recommending a relatively heavy type of petroleum-base rust preventive compound and an article by S. M. DePoy, Delco Products Div., General Motors Corp., on Rectification of High Speed Steel Salts are featured in the January issue of Production Data From the Houghton Line, the house organ

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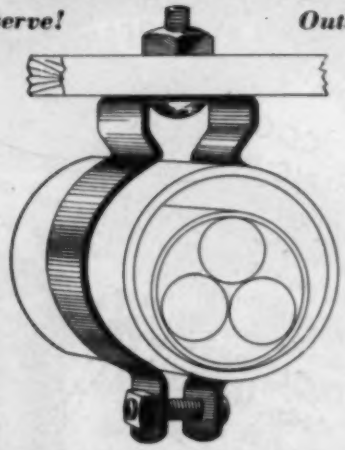

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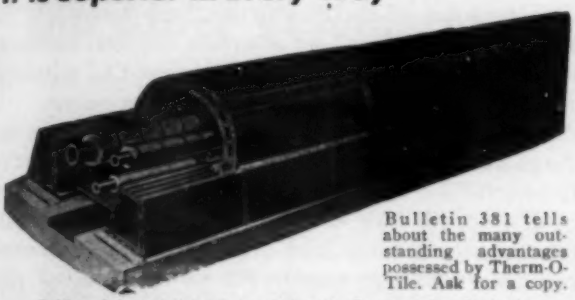

Bulletin 381 tells about the many outstanding advantages possessed by Therm-O-Tile. Ask for a copy.

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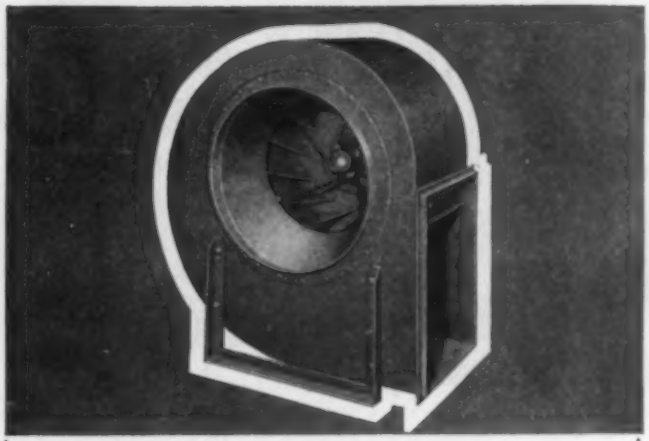

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Forward and Backward Curved Blades In all sizes, wheels 12 to 72 in.

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ANDERSON - STOLZ CORPORATION
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of the E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa. The importance of using proper quenching oils in heat treating steels is stressed and methods of blackening steel are discussed by F. L. Atkin, Chief Chemist, Sparks-Withington Co. Recent developments in the company's line of soluble cutting oils and oils used to free the flow of metals and to protect dies in cold drawing metals are included.

Oxy-Acetylene Flame Cutting and Welding

No. 6104—So You're Starting Your Own Welding Shop is the title of an article featured in the January issue of the house organ, Oxy-Acetylene Tips, published by The Linde Air Products Co., Unit of Union Carbide & Carbon Corp., 30 E. 42nd St., New York 17, N. Y. Directed toward veterans who may be considering a welding business of their own, the three essentials for success in any business—an adequate market, sufficient capital, and business ability—are discussed in a helpful manner.

Also included in this issue are tabulated data on the melting points of metals and alloys, a discussion of bronze-surfacing worn pump impellers, and a description of a simple pipe cutting machine using an oxy-acetylene cutting torch and either a hand or electric driven gear reduction system for slowly rotating pipe of 9 to 16 in. diameter.

pH Control Instruments

No. 6105—The Bristol Co., P. O. Box 1790, Waterbury 91, Conn., has announced a new bulletin (No. pH1302) describing the company's line of pH control instru-

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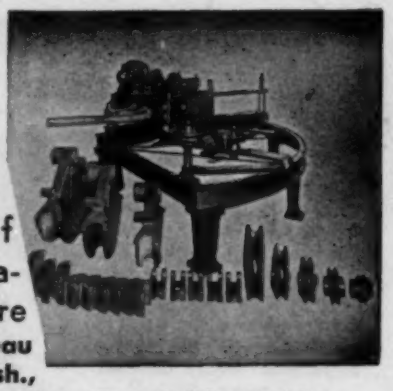
12 types from which to select; hand operated capacities:- ¼ to 6" inclusive; motor operated:- ½ to 8" inclusive. Now indispensable to contractors, shipbuilders, ordnance plants and thousands of others. These machines will be essential also in industrial conversion after the war.

12,000 customers—and more—can testify to the indispensability of "American" machines. Here are **a few users: Bureau of Ships, Wash., D. C.; Henry J. Kaiser Co., Calif:; Pacific Bridge Co.; Bethlehem-Hingham Shipyards; Hercules Powder Co.; Stone & Webster; E. I. Du Pont de Nemours & Co.; Crane Co.**



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DIAL
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Economize WITH POWERS
TEMPERATURE REGULATORS
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Use a Powers No. 11 Temperature Indicating Regulator when you want the advantages of an easy-to-read dial thermometer combined with a dependable self-operating regulator. The dial thermometer gives a visual check on the performance of the regulator and makes it easy to adjust for the required operating temperature. Various dials and ranges are available.
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gives you instantaneous, direct readings of air velocity in feet per minute. Hold it in the air stream for low range readings; use the tube-connected special jets for high range readings or inaccessible locations. That's all there is to it, and once you use the Alnor Velometer you will never tolerate other methods.

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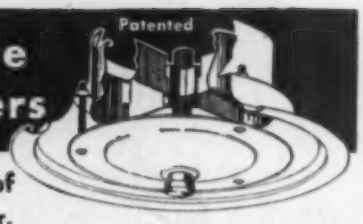

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Whether they are used in heating, cooling, ventilating or combined systems, Kno-Draft Adjustable Air Diffusers can be adjusted quickly and accurately for system balancing and individual or seasonal requirements. By simply turning the air adjustment screws (easily accessible from under the unit) the inner cone may be raised or lowered to secure any angle of air direction required. The built-in volume damper (regulated by the hand-turning knob) varies the air outlet aperture uniformly without affecting the outlet velocity or diffusion pattern.

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An important advance in the history of the pumping industry now for the first time makes available a new conception of integrated pump service to customers. *Dayton-Dowd*, long associated with sustained high quality—a distinguished name on centrifugal pumps—has become an integral part of the *Peerless Pump* organization.

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Factories: Los Angeles, Calif., Quincy, Ill., Canton, O.

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Save Time, Trouble and Money Seal Pipe Joints and Gaskets with Leakproof KEY Graphite Paste

Key Graphite Paste will hold a pipe joint leakproof against all petroleum based liquids. Key lubricates as it seals and positively will not freeze the joint.

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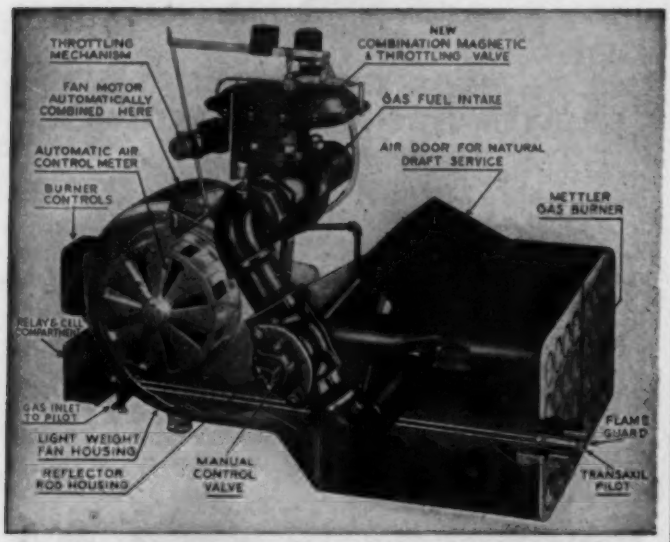
The Mettler "FAN-AIR" Gas Burner



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FOR ALL Purposes Kinds of gas Pressures

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ments. Continuous controllers and recorders including electrode assemblies and accessories are described. The bulletin includes engineering and technical information relative to pH theory and measurement and a number of installations are illustrated.

Pipe Line Filters for Air and Other Gases

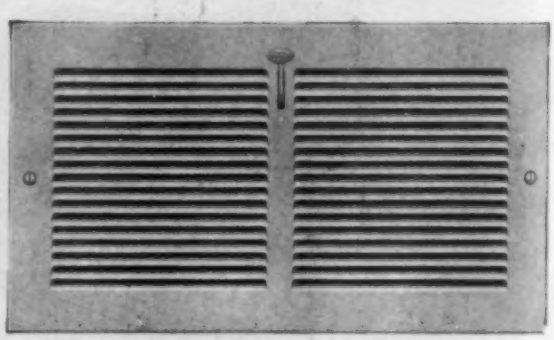
No. 6106—Dollinger Corp., 9 Centre Park, Rochester 3, N. Y., has issued an 8 page bulletin illustrating and describing the company's line of "Staynew" pipe line filters which are designed to remove dirt, rust, pipe scale, oil, and water from either pressure or vacuum piping systems handling air or other gases.

Prefabricated Ducts And Fittings

No. 6107—A new 28 page catalog (No. 46-AC-6) showing improved and simplified methods for installing prefabricated ducts and fittings has been issued by the Clayton & Lambert Mfg. Co., Middletown Div., Middletown, O. Fittings and ducts for both round and rectangular systems are illustrated and price lists are included.

Pressure Operated Switches

No. 6108—A new line of "Starbird" pressure-operated electric switches, which are designed for controlling pumps, motors, warning devices, valves, etc., is described and illustrated in an 8 page folder issued by the Meletron Corp., 950 N. Highland Ave., Los Angeles 38, Calif. Three basic models are offered for use on operating pressures from near 0 psi to 5000 psi.



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This model is a simple, sturdy, moderate priced register suitable for most forced air heating jobs. Modern and pleasing in appearance, it has single louvre and bendable fins, set when delivered at about 22° downward. Furnished for wall and baseboard registers and intakes. It's an efficient, easily installed register, which does not run up the cost where the job must be kept within limits.

Auer offers a complete line of floor, base, and wall registers and return faces, for gravity or air conditioning systems—including all air directional types. We also make flat metal grilles. Ask for Auer Register Book—or special Grille Catalog "G."

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Many foremost manufacturers, having discovered our specialized skill in our particular line, have entrusted us with a great variety of precision pipe and tube work, including bending, coiling, expanding, flattening, brazing and welding.

Swan engineers and technicians, dealing continually with piping, can advise on your bending requirements and offer valuable suggestions on design and economical methods of installation. We invite your inquiries.

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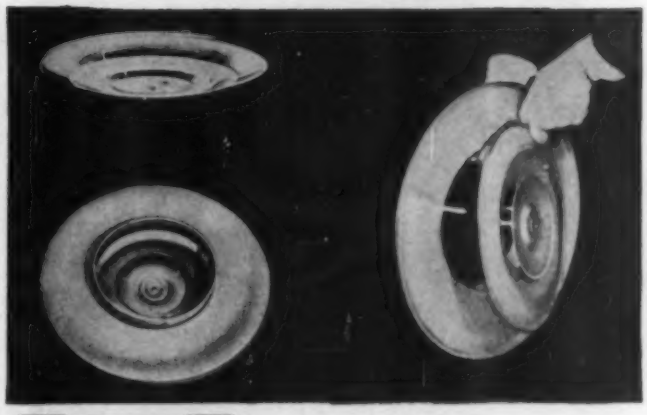

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are easy to install

TYPE CSF (Top)

TYPE R

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Because of their simple, functional design, Agitair Air Diffusers can be installed tightly and "in line" with a few simple fastenings and a minimum of duct work.

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Mail post card for free sample. Rutland Fire Clay Co., Dept. H-32, Rutland, Vt. Also makers of Rutland Retort Cement, Furnace Cement, Asphalt Paint, Concrete Patcher.

THE UNIONS WITH THE RECESSED BRASS SEAT

JEFFERSON SPECIALTY UNIONS

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Jefferson Union Tees with union on the outlet assure labor savings and better piping jobs because they take the place of an all-female union, two nipples and an ordinary tee. Three joints are thus saved. Available in All-Female and Male and Female threads.

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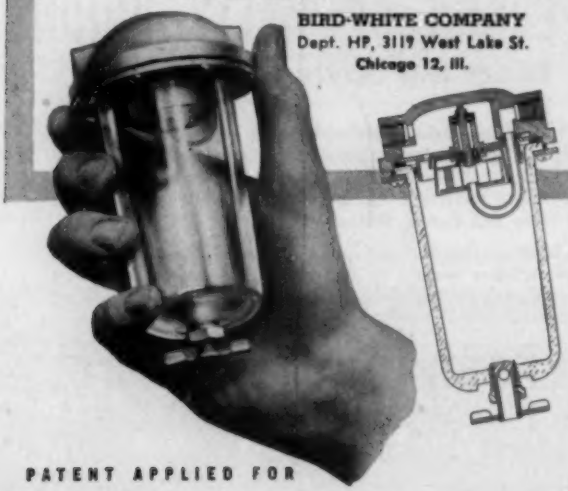

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Protective Paint

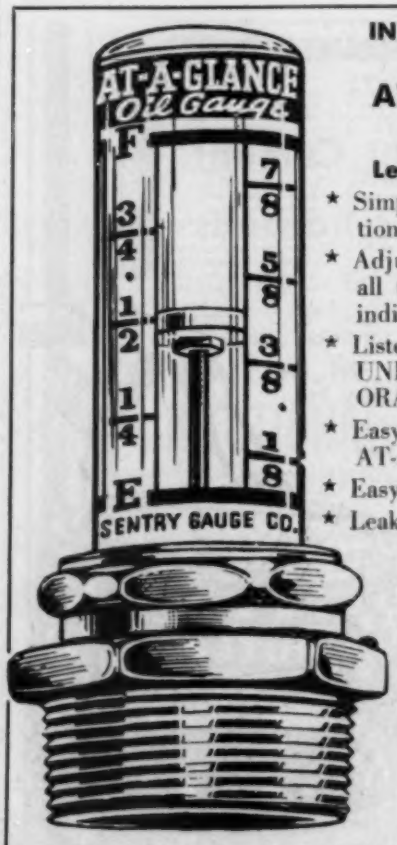
No. 6109—"Pen-Kote 500" maintenance paint, which is said to be extremely resistant to acids, alkalis, water, alcohol, salt brine, gasoline, oil, and many solvents, is described in a 4 page folder issued by the Peninsular Chemical Products Co., 6795 E. Nine Mile Rd., Van Dyke, Mich. According to the manufacturer, it is non-inflammable, quick setting, odorless, and easy to apply.

Pumps

No. 6110—Sixty types and styles of vertical and horizontal pumps manufactured by Peerless Pump Div., Food Machinery Corp., 301 West Ave. 26, Los Angeles 31, Calif., are illustrated in a new bulletin (No. B-136) just issued. The various types offered include deep and shallow well pumps, "Hi-lift" pumps, gasoline and fuel oil transfer pumps, and domestic water pumping systems.

Self-Locking Nuts

No. 6111—Six types of self-locking nuts are described in a 1 page leaflet and a smaller 6 page folder issued by the Elastic Stop Nut Corp., 2330 Vauxhall Rd., Union, N. J. An elastic compression collar which is held in the head of the nut is said to provide many features such as permanent tightness under conditions of severe shock and vibration, the ability to lock anywhere on the nut without creeping or damaging the bolt and assembled parts and without freezing in place. On flanged joints where a washer is used next to the flange, the nut is said to prevent water or liquid leaking out of the



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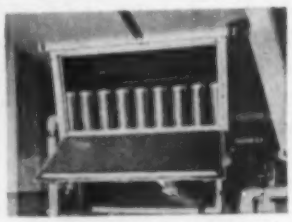

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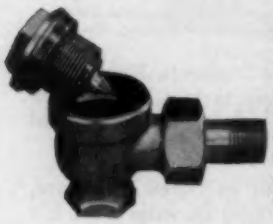

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War Work by Piping Contractor and Fabricator

No. 6112—A 4 page pamphlet, entitled For the Record, has been issued by the Midwest Piping & Supply Co., 1450 S. Second St., St. Louis 4, Mo. This booklet briefly describes the company's contribution to important war projects, the most important of which was probably the fabrication and erection of process piping for the Kellex Corp. on the atomic bomb project.

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